THE

ELECTRICAL REVIEW.

VOL. LXVI. JANUARY 7, 1910. No. 1,676.

ELECTRICAL REVIEW.

Vol. LXVI.] CONTENTS; January 7, 1910. [No. 1,676.

	Page
1909	1
The Clapham Junction Fire	2
The Importance of the Inventor in Relation to Electrical Progress	2
The Human Factor	3
Insulated Wire in India	3
Artificial Loads for Generator Testing (*illus.*)	4
The Determination of the Temperature of the Filaments of Incandescent Lamps (*illus.*)	5
Some Large Induction Coils (*illus.*)	6
The Physical Society's Exhibition (*illus.*) (*continued*)	7
New Electrical Devices, Fittings and Plant (*illus.*)	10
Parliamentary	10
Correspondence:—The Heurtley Test and Cable-Fault Localisation—The Industry and the Institution—The Use of Electricity in Coal Mines—Methods and Practice in the German Electrical Industry—Ozone	11—12
Fuel Supply Contracts on a Heat-Unit Basis (*illus.*)	13
The Stopping of Lifts	15
Common Commutator Troubles (*illus.*)	16
Business Notes	18
Notes	25
City Notes	27
Market Quotations	28
Stocks and Shares	28
Share List of Electrical Companies	29
Metal Market.—Fluctuations in December	31
Electrical Works in Public Thoroughfares	31
Reviews	33
Proceedings of Institutions:—	
Some Quantitative Measurements in Connection with Radiotelegraphy (*illus.*)	34
Efficiency of Short-spark Methods of Generating Electrical Oscillations (*illus.*)	37
On the Use of the Flicker Photometer for Differently Coloured Lights (*illus.*)	38
Contractor or Manufacturer?	39
Foreign and Colonial Tariffs on Electrical Goods	39
New Patents Applied For, 1909	40
Published Specifications	40
Contractors' Column	...Advertisement pages 62 and 64

THE ELECTRICAL REVIEW.

Published every FRIDAY, Price 4d.

The Oldest Weekly Electrical Paper. *Established 1872.*

TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY.

OFFICE:—4, LUDGATE HILL, LONDON, E.C.

Telegraphic Address: "AGREKAY, LONDON." Code, A B C.

Telephone Nos.: Holborn 983; Central 4425 (Editorial only).

ALL Letters should be addressed to the Proprietors, H. Alabaster, Gatehouse & Co.

ADVERTISEMENT RATES ON APPLICATION.

The "Electrical Review" is the recognised medium of the Electrical Trades, and has

BY FAR THE LARGEST CIRCULATION

of any Electrical Industrial Paper in Great Britain.

SUBSCRIPTION RATES.—Per annum, postage inclusive, in Great Britain, 19s. 6d.; Canada, £1 1s. 8d. ($5.30). To all other countries, £1 10s.

BINDING.—Subscribers' numbers bound, including case, for 4s. each volume.

CASES.—Cloth Cases for Binding can be had, price 2s. 6d. each; post free 3s. 9d.

READING CASES, to hold from One to Twenty-six Numbers until the volume is complete for Binding, can be had from the Publishers, Price 6s., or Free by Post (in Great Britain), 6s. 6d.

FOREIGN AGENTS.—New York: D. VAN NOSTRAND, 23, Murray Street. TORONTO, ONT.: WM. DAWSON & SONS, LTD., Manning Chambers. Paris: BOYVEAU & CHEVILLET, 22, Rue de la Banque. Berlin: ASHER & Co., Unter den Linden.

Cheques and Postal Orders (on Chief Office, London) to be made payable to MR. H. ALABASTER, 4, Ludgate Hill, E.C.

THE
UNIVERSAL ELECTRICAL DIRECTORY
(J. A. BERLY'S).

1910 EDITION IN PREPARATION.

H. ALABASTER, GATEHOUSE & CO.,
4, Ludgate Hill, London, E.C.

1909.

THE year has closed with numerous indications, we are glad to say, of a gradual but general improvement in the world's trade, in which this country shares. There is nothing erratic or jerky about the movement, no signs of a boom; but just as a steadily rising barometer is an indication of fair weather, while a rapid change implies a storm, so does the trade barometer hold out to us the prospects of an enduring and substantial recovery from the depths of depression through which we have passed in recent years.

The improvement, unfortunately, has not yet made itself appreciably felt in connection with market prices; there is a lack of cohesion about the British electrical trades, a feeling of every man for himself, which, unfortunately, tends to maintain a fierce and unreasoning competition even when there is plenty of business for everybody; but we hope that prices will mend and prosperity return before we enter upon the next retrospect.

As for the year's work, there is little of note to record; the influence of the metallic-filament lamp upon the manufacturing, contracting, and supply branches of the industry is the most prominent feature of the year, which has been characterised by no striking event or invention of fundamental importance. If the efficiency of the incandescent lamp had been raised by stages instead of by a jump of 2½ watts, the disturbance created in the supply department by its improvement would have been lessened; on the other hand, we think the electrical world will ultimately be none the worse for the sharp stimulus that it has received, which has compelled it to study the cheapening of services and wiring, and to prosecute the campaign of development in the directions of power, heating and cooking with an ardour that might otherwise have been wanting. Thus history repeats itself, for the gas companies passed through a very similar experience some 15 years ago—and profited by it.

Although in very many cases the revenue of supply undertakings has become stationary, or even receded, we are pleased to record that the set-backs have not as a rule been very serious, and they have been off-set to some extent by reduced working costs; in some instances material advances were recorded, in spite of the tungsten lamp, and the demand for power supply in industrial areas is still very far from satisfied. One factor which will help the suppliers is the revolution in street lighting which is in progress—thanks to the wire lamp. Towns which are not trying the new lamp on a practical scale form the exception; in some cases large numbers of gas lamps are being converted, in spite of the rather hostile attitude of the Local Government Board, which appears to have a prejudice in favour of gas. The extraordinarily long life, and well-maintained efficiency, of the tungsten lamp render it ideally adapted for street lighting;

although the flame arc, which has made great progress of late, remains absolutely without a rival for the lighting of the more important thoroughfares.

The remarkable advance that has been made by the manufacturers of metallic-filament lamps during the year deserves recognition; in spite of the obvious difficulties in the way of manufacturing lamps of low candle-power for high voltages, they have progressively reduced the candle-power until the 16-c.p. 200-volt lamp is actually in sight, if not on the market. In view of what has already been accomplished, it would be extremely rash to predict a limit to the value attainable. It is clear, however, that the voltage question is fast losing its importance, and the rush to the opposite extreme of absurdly low pressures will probably go out of fashion; the use of electric motors, cookers and heaters on these low-voltage circuits is greatly hampered by the excessive current required, and there is little to be gained by using a lower pressure than 100 volts.

We have so recently dealt with the Electric Lighting Acts (Amendment) Act that we need do no more than mention it here as one of the year's landmarks; and the Home Office Regulations for Factories and Workshops came into force in July. The extending use of electricity in mines has led to the discovery of many defects in the Special Rules of the Home Office in this connection, and, incidentally, to the formation of a new Institution.

The opening of the single-phase section of the L.B. & S.C. Railway must not be overlooked; we trust that this will be followed by many other conversions from steam to electric traction on railways.

Tramway work has been almost at a standstill during the year; but little fresh ground has been broken, and what work has been carried out has taken the form of detail extensions or the conversion of horse tramways, of which the L.C.C. still has a large proportion to electrify. The railless trolley has been much discussed and investigated by numerous municipal deputations, whose members are better qualified to support the *rôle* of sightseers than to compare the merits of rival modes of transit. Much cry and little wool has been the result, though at last we have a sample section, at Hendon, to show Britishers what the system is like without the necessity of enjoying a Continental holiday at the ratepayers' expense. The acme of futility, perhaps, was reached when the L.C.C. solemnly authorised Mr. Mordey to put the G.B. system to the test in the East-end, and, after the company had demonstrated its feasibility to Mr. Mordey's satisfaction, tamely submitted to the dictation of its own staff, and ignored its consulting engineer's reports. That the G.B. system could have been made a practical success in London we have no doubt—neither had Mr. Mordey. But the history of electric traction in London has been marred by prejudice and politics from the beginning.

Regarding the electrical industry from a less parochial point of view, the leading features of the year's record abroad appear to have been the progress made in the development of natural sources of power and in the further application of electricity to metallurgical processes; wireless telephony is still, as might be expected, in the air; wireless telegraphy continues to demonstrate its usefulness for communication with ships at sea, and its inefficiency for trans-oceanic communication compared with cables. Some little advance has been made towards cheaper cable communication throughout the Empire. The activity of Germany in the submarine cable field calls for special mention.

Everywhere the evidence shows steady progress, and we would not wish it otherwise. Too hasty steps are apt to stumble. The new year starts with favourable prospects, and it is our earnest hope that the electrical industries will prosper abundantly henceforth.

The Clapham Junction Fire.

The inquest was concluded on Tuesday last, and the verdict of the jury was to the effect that the fire was due to the breaking of an electric incandescent lamp in one of the windows. While the opinion of a jury is not necessarily infallible, we regret to say that in this instance we can find no reason to doubt its accuracy, in view of the evidence given during the inquiry. The fact which we mentioned last week—that an incandescent lamp broken over cotton wool will readily ignite the latter—has been confirmed from two other sources, and must be regarded as proved.

No blame attaches to the proprietors or contractors, though it was unfortunate that the insurance company's attention was not drawn to the special window lighting, as in previous years.

The lesson has been a sharp one; we hope it will not be lost upon those responsible for similar installations, and that the lives which have been sacrificed may be the means of saving others from a like fate. The Phœnix Fire Office rules forbid the use of portable lamps in windows where inflammable goods are kept, and it would be well to make this rule obligatory in all such cases. It has already been proposed that the L.C.C. shall obtain powers to inspect shop premises with a view to providing against fire risk; but it is not only in London that precautions are necessary.

The Importance of the Inventor in Relation to Electrical Progress.

Amongst the reasons for the rapid growth of the German chemical industries, the *Times*, in a recent article, includes the employment and encouragement of trained chemists, two large firms being specified as employing 200 and 250 chemical experts respectively. These men are content to accept comparatively low salaries so long as royalties are paid to them upon any discoveries they may make which their employers decide to patent.

It is said of electrical manufacturing, that either British inventors are less fertile than their Continental cousins, or they receive less inducement to exert their faculties.

We do not believe that the country which initiated nearly all the important inventions of the nineteenth century can suffer from lack of inventive ability in the twentieth, hence we are compelled to conclude that lack of encouragement is the reason why our experts have failed to uphold our scientific and mechanical supremacy.

It is doubtful whether any electrical manufacturing firm in this country has agreed to allow royalties to members of its technical staff, who initiate new devices or designs worthy of protection, and the chances of an individual receiving credit for any improvement he may have introduced are extremely remote—credit, in this instance, being understood to apply to the industry in general, and not to the inventor's *confrères* on the staff of one particular undertaking. Instead of an arrangement contemplating the payment of royalties, the members of the technical staff in a manufacturing concern are generally forced to sign an agreement making over

to the firm all inventions initiated by them during their term of service, and although a limited company is compelled to couple the inventor's name with its own in applying for letters patent, in some cases great care is taken afterwards to suppress all reference to the author of the improvement.

This attitude naturally leads to the suppression of new ideas: the would-be inventor finds his employer willing to take up the ideas of an outside patentee who gets both money and credit for his invention, whilst the unfortunate home aspirant cannot hope for any reward whatever.

To develop a new idea into a marketable form almost always involves patience and perseverance, which can only be induced in the ordinary individual by the hope of reward either in the form of credit or money; and so long as this hope is generally withheld, a vast mass of inventive effort will be lost to the nation.

It is difficult to understand what risk could possibly follow an agreement to pay a small royalty upon patentable inventions thought out by employés in manufacturing undertakings. The principle of sharing any saving effected by individual industry with the employé concerned, has long since been conceded in the form of premium and bonus piecework systems, and there would appear to be no sufficient reason why this principle should not be extended to include inventions.

As regards the independent inventor, the conditions are much more favourable, as he cannot easily be deprived of the fruits of his industry, and both money and credit follow the taking up of his invention by a manufacturer. Furthermore, the manufacturing concerns in this country are awaking to the importance of new inventions, and they are much more willing to consider new devices or designs from outside sources than was the case a few years ago.

The Human Factor.

The rapid strides made in the design and construction of machinery during the last few decades have brought the question of efficiency within the region of "practical politics" in engineering circles generally. Not many years ago the efficiency of an engine or boiler was not of much account in the commercial sense, but new conditions and increasingly severe competition have brought about a radical change, so that now in certain classes of machinery it can be claimed without any undue rashness that the possible limit of efficiency has been reached, or very nearly so.

With the spread of educational facilities, it might also be assumed that the efficiency ratio had gone up also in the case of the human factor, that most important part of all business systems. We venture to express the opinion, however, that there is a doubt about this. One of the most amazing signs of the times is the woeful display of ignorance of the most indispensable and commonplace matters which are related to, and inseparable from, everyday affairs. The seemingly accepted mode of procedure adopted by many is to hang on, in the hope of muddling through. So long as a man can fill his groove with some show of responsibility, he need not worry about getting to the bottom of matters which come to him every other day, but which he might soon understand clearly with a little concentration. Such is the gospel of to-day. To quote an example, he may be able to accomplish the fundamental operations in decimals, but he returns to the old rules when an intricate calculation is involved, because he does not like to tackle the really simpler method.

Again, in this connection there is a factor which is absent in the case of a machine, and which seriously affects the level of efficiency. Slackness in work of all kinds is rampant in this country, and it is an evil which requires more drastic treatment than it always receives. Such slackness usually either means that the work is done later, with more hurry than is desirable, or that the employer is paying for service not rendered. Either the employé acquires a reputation (under false pretences) for being fond of late hours at work, or his employer's business suffers from the dilatory methods adopted. Few opportunities are lost of abusing employers for tyrannical measures, but often the employés overlook the right of the employer to conscientious effort from them, which is so often the minus quantity.

Man will probably never be infallible, but it is infinitely preferable to make mistakes occasionally in the course of steady application to work than to avoid such by shifting responsibility and shirking difficulties for want of spirit to tackle them. For absolute laziness there is nothing but condemnation, and in our opinion one of the things lacking to bring about better understanding between master and man is that the latter shall grant to his employer that consideration which he himself expects, and if this is done slackness will lessen, and efficiency will increase.

Insulated Wire in India.

Probably nowhere in the world has the problem as to what is the best grade of insulated wire to use been more keenly discussed than in India, and even after a dozen years' experience of installation work, there is still considerable diversity of opinion on the point. The climatic and physical conditions are so extremely severe that this absence of uniformity is not to be wondered at. Government specifications generally call for 600-megohm grade wire, while some of the electrical firms of the longest experience use nothing but wire of the very highest grade obtainable, and think it none too good for the exacting conditions of the tropics.

The difficulties to be faced in installation work are (1) intense dampness of the atmosphere during the rainy season, causing an accumulation of moisture and condensation in casing or conduit; (2) saltpetre and other harmful chemicals contained in brickwork and plaster, which, by coming in contact with conduit, or porcelain tubes passing through walls, destroy them and cause the insulating covering of wires to perish; (3) white ants, which very often, in a wholesale manner, devour insulating covering.

The one point of uniformity that universally obtains is that all casing, wherever used, is spaced off the walls by means of small porcelain buttons, thus ensuring the minimum points of actual contact with a building.

When the fiat of the C.M.A. went forth a few years ago in a praiseworthy endeavour to standardise both dielectric and wire prices it was hoped that the difficulties, or, at any rate, some of the difficulties of the ordinary consumer of electricity had been overcome, and that by employing fairly reputable contractors he would at least be guarded by the standards of the Cable Makers' Association. But this, according to one of our Indian correspondents, is not so. A considerable quantity of low-grade and inferior German, French, and American wire is being used daily, and the C.M.A. rules and standards are practically a dead letter, except where Government specifications have to be obeyed, and except also among contractors who consider their good name of more importance than a few shillings saved on inferior material.

For the consumer there is very little hope of redress. In towns where there is an electric supply company, so long as the installation tests up to the mark, it is connected on to the mains regardless of workmanship or quality of material used. For private installation work there is practically no test other than that of seeing the lights glow, or the fans work, and most engineers know of what little practical or lasting value these tests really are.

Of course, the same evil practices obtain more or less at home and on the Continent, but the adverse conditions referred to above exist only in tropical countries, and hence the results are more accentuated.

ARTIFICIAL LOADS FOR GENERATOR TESTING.

[COMMUNICATED.]

There can be little doubt that a water load is the only generally satisfactory and suitable means of dissipating large amounts of energy at high voltages, though alternative methods may be convenient in special cases. Confining attention, therefore, to water loads—the choice of the water supply is the first point to be determined, since on the specific resistance depends the size of tank that will be required and the safe voltage to be placed across a given tank. Practically, the only property of water concerning us in this case is its specific resistance, and this is so dependent on the composition of the water, that preliminary tests to determine the resistance per cm.^{3} must be conducted before setting out on the tests proper. There is no advantage in using very pure water (*i.e.*, water of very high specific resistance) unless the voltage to be dropped is abnormal, and even then other limitations (such as the permissible voltage drop per ft. in the case of wooden tanks) arise. A convenient specific resistance is about 1,000 w./cm.^{3} (33 w. per ft.^{3}), this being often obtained by mixing clean river or canal water with condenser discharge water. It is preferable, however, to use the river or canal water alone if possible, as there is then no need to cool and re-use water (specific resistance then usually = 16 w./ft.^{3}). On similar grounds, solutions of various salts in water should not be used if at all avoidable. In some low-voltage tests, however, it is essential to use such artificial liquid resistances, and in these cases cooling tanks (water cooled if necessary) must be provided to enable the re-use of the liquid. The effect of various percentages of the most commonly used salts is shown in fig. 1, the conductance of the solution being expressed as so many inches per volt drop when working at 1 ampere per sq. in. This is a more convenient expression for tank design than the usual specific resistance per cm^3. If an alkaline or simple water electrolyte be employed, the electrodes should be of cast-iron, while, if acid is used, lead or carbon plates must be substituted. Copper electrodes are used with $CuSO_4$, but the latter is only used for the lowest voltages, its advantage being the absence of polarisation. Additional objections to the use of electrolytes such as the above are the fumes, creeping and shortened life of the electrodes, tank and equipment generally. Aluminium sulphate is a convenient electrolyte for low-voltage work, and gives neither fumes nor sediment. For high-voltage tests such complications are not necessary, and would indeed be very difficult to employ, the usual trouble being to obtain a *sufficiently pure* water supply *cheaply* and in *sufficient bulk*.

The effect of temperature on the electrical resistance of liquids must not be ignored. With many electrolytes this temperature coefficient amounts to 2 — 3 per cent. per 1° C., and is always negative. In the case of average river or canal water the temperature coefficient is usually 0·7 to 1·0 per cent. per 1° C.; but, unfortunately, the variation of resistance with temperature is not linear, this being shown by the curves of figs. 2 and 3. In these, the experimental curves are due to Morcom and Davis respectively. The writer has determined equations which satisfy these experimental curves fairly closely between 50° and 160° F., which well covers the range of practical working. As shown in these figures the addition of a term $a\,t^2$ to the ordinary linear equation ($R = R_0\,(1 + a\,t)$) results in a reasonably accurate law. The coefficient of t shows that the ordinary "temperature coefficient of resistance" is about 1 per cent. per 1° C., and is negative (being — 1·05 and — ·065 in these two cases); the t^2 term is not of great importance. These remarks only hold if no definite compound forms between the water and its impurities: in the latter case the resistance variations (with t and with per cent. of impurity) can no longer be predicted.

Having commented on the properties of water, the most convenient resistance, we may consider the tank construction. In many cases it is necessary to employ a single large tank, such being ready to hand, but it may be pointed out that it would always be preferable to construct three small wooden tanks (one per phase), these being long, shallow and narrow, since this form is by far the best where a large amount of energy at high pressure has to be dissipated. Assuming, however, that a single large tank is to be used for the load, it would be advisable to place the "neutral" centrally in the tank and the three-phase electrodes symmetrically round it, as in fig. 4. By raising these three electrodes out of the tank the load can be decreased as desired: the degree of regulation possible may be extended by mounting the high-tension electrodes on radial rails, then running them symmetrically to and from the neutral pole as required. If a smaller metal tank be employed the construction might well be as shown, there being no difficulty in dissipating in such a tank 5,000 kw. at 7,000 volts. In small tanks, whether of wood or iron, drain holes must be provided, so that in case of failure of the water supply, the water level in the test tank rapidly falls far enough to compensate for the great fall in specific resistance of the water consequent on its rapid heating up on the cessation of the circulation (see figs. 2 and 3). This fall in resistance if allowed to take unrestricted effect would double

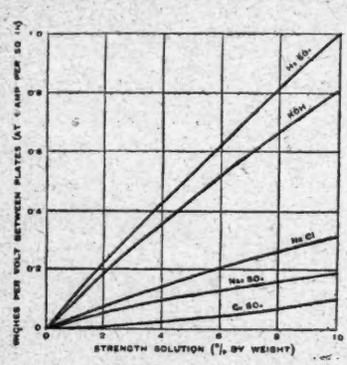


Fig. 1.

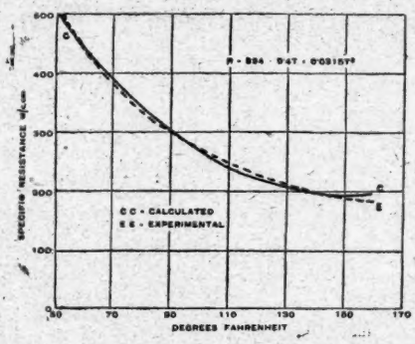


Fig. 2.

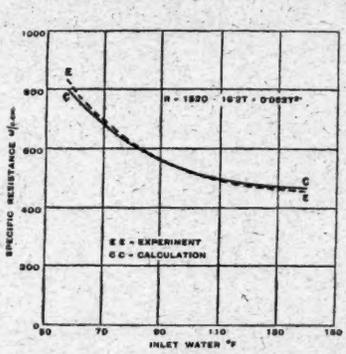


Fig. 3.

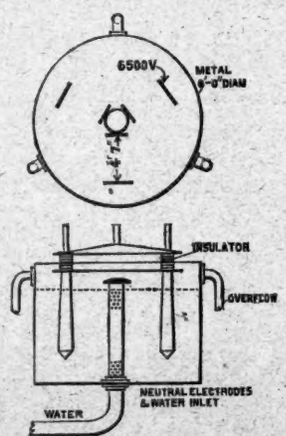


Fig. 4.—Metal Water-Resistance Tank for High Voltages.

or triple the load on the generator, and hence seriously damage it if the machine were on normal full load at the time of the water failure. Complete draining of the tank must not occur in such an emergency, but the increased resistance of the load must give the operator time to open the generator switches. To open the generator circuit by running off all the water in the tank would be disastrous to the tank.

In small tanks the load is frequently varied by the water level, by controlling the inlet water cock or preferably by adjusting the weir board at the overflow. Other methods available are the raising or separating of the electrodes, varying the immersed area in the former case and the length of the intervening liquid column in the second. In effect the two methods are identical, and in some cases they are combined by mounting the movable electrodes on inclined rails, so that as they are drawn back they automatically rise out of the electrolyte. The latter arrangement is open to the grave disadvantage, for H.T. work, that without a more or less elaborate clutch or pawl device there is a risk of the electrodes being accidentally allowed to run back down the plane, so "shorting," or, at least, overloading the generator.

Wood v. Slate and Metal Tanks.—Should it be decided to install a separate testing tank (which is advisable for the reasons given), the question arises as to the material to be employed. The reason why wood has been placed *versus* all other tank materials in the heading of this paragraph is that it is extraordinarily cheap compared with the other materials suggested; it is for this reason that slate, which possesses the same advantages as wood over iron, in as far as it is non-conducting, has not been included in the same category as wood. Slate, brick and earthenware tanks are very suitable for experimental use, but their high capital cost is against them. Their advantages over wood as regards greater imperviousness and freedom from charring or firing are practically non-existent if the wooden tanks are made of good timber, well tarred and caulked at all joints. Under these conditions, wooden tanks are, if anything, less leaky than slate vessels, the jointing of which is troublesome. It goes without saying that any iron angles, stays, &c., used in wooden tank construction must be placed *outside* the tank. The obvious objection to metal tanks, apart from higher cost of construction and upkeep (rusting, &c., being serious) is that they provide a low resistance shunt path to the body of the water; hence the water path from the electrodes to the metal walls must be comparable with the path between the electrodes. This necessitates a large tank, and so further increases the difficulty of obtaining high resistances between electrodes, *i.e.*, dealing with low loads and high voltages. Attempts to insulate the face of the metal with enamel or glass have not proved successful; the difficulty of permanently jointing the glass proved the obstacle to its use in making long metal tanks possible (such as are successfully used in wood). Hence it is that metal tanks are usually cylindrical in shape (fig. 4); low loads are impossible with any elongated formation. Metal tanks can be well earthed, and in this respect are rather safer than wooden tanks, where the only "earth" possible is *viâ* the discharge water—a relatively high resistance path. Metal tanks cannot char or burn, but they often corrode considerably, and a properly waterproofed wooden tank, in the construction of which no metal is exposed to the water, does not char or burn, so long as the voltage drop per foot does not exceed 500—600 volts.

Summarised, the relative advantages of wood and metal, the two chief rival materials, are:—

WOOD.	METAL.
Advantages.—Cheap and easy to erect (making it particularly suitable for temporary jobs). Light loads at high voltage easily obtained.	*Advantages.*—Does not char, fire, or leak (?). Stronger (?). Possesses some advantages where a permanent testing plant is required.
Disadvantages.—Liability to char and fire (?). Sides insulated, hence danger of shock therefrom, or even from water. Operator must be on insulated platform and mat.	*Disadvantages.*—Expensive to erect, heavy. Depreciation considerable, liable to corrosion. Very large tank needed to get light loads, and at high voltage this is particularly troublesome.

Doubtful points in this comparison are queried.

THE DETERMINATION OF THE TEMPERATURE OF THE FILAMENTS OF INCANDESCENT LAMPS.

BY L. CROUCH.

THE extreme importance of the filament temperature as affecting the efficiency of incandescent lamps is well known to all illuminating engineers. The higher efficiency of metallic-filament lamps, as compared with the older carbon-filament types, is largely due to the higher temperature at which the former may be operated without fusion or rapid sublimation or disintegration. Selective emissivity undoubtedly plays a not unimportant part in improving the efficiency, but it is equally indisputable that a comparatively few degrees Centigrade higher filament temperature results in a quite disproportionate increase in luminous efficiency. In all "hot" light sources (*i.e.*, those not depending on the "cold" light of phosphorescence or fluorescence) it is desirable to obtain as high a value as possible for the quotient—

$$\frac{\text{luminous radiation}}{\text{total radiation}} \quad \ldots \quad \ldots \quad (1)$$

The manner in which this ratio rises with temperature is indicated in fig. 1. Beyond a temperature of 1,800-2,000° C. small temperature increases are most valuable as rapidly increasing the luminous efficiency of the source (expressed

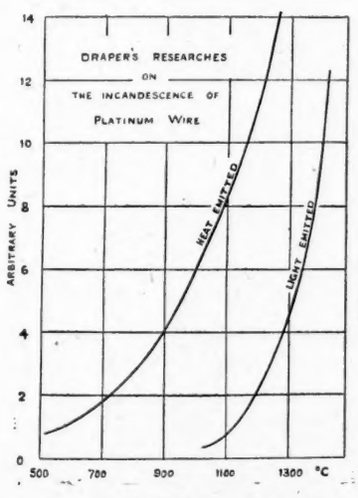


FIG. 1.

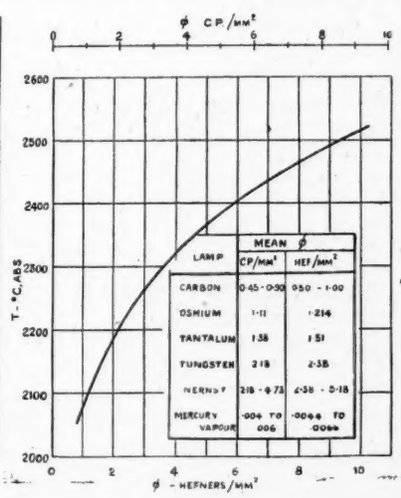


FIG. 2.

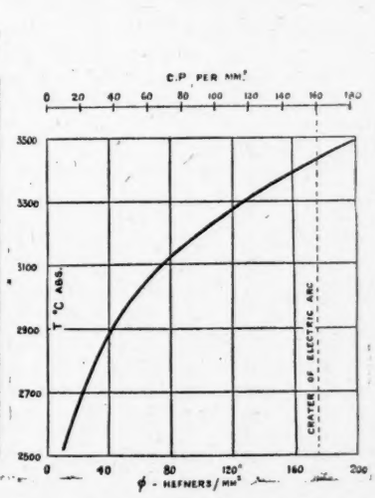


FIG. 3.

by the quotient (1) above). The data of Table I show that, of the total radiation from two carbon and tungsten lamps of equal input-wattage, the luminous radiation is about three times as great in the case of tungsten as in that of the

TABLE I.

Lamp.	Input watts.	Radiated watts, total.	Light radiated, watts.	Visible/total radiation %.	Visible/total energy %.	Horizontal c.p. (hefners).	M.S.C.P. (hefners).	Actual watts per M.S.C.P.	Energy equivalent of 1 spherical hefner, watts/c.p.
Carbon	100	64·8	2·07	3·2	2·70	32·1	24·5	4·09	0·085
Tungsten	100	59·0	5·37	9·1	5·36	95·0	71·7	1·42	0·075

carbon filament. This is partly attributable to the selectivity of the tungsten and to its lower emissivity (the latter enabling the maintenance of a given temperature with a less expenditure of energy), but largely to the 300-500° C. higher temperature at which the metallic filament can be run (see Table II).

Platinum, while one of the most "selective" radiators known, cannot compete with tantalum and tungsten for use

TABLE II

Material.	Melting point, ° C.	Running temperature, ° C.
Carbon ...	Sublimes or disintegrates if temperature > 1,900—2,000° C.	1,800 in 4 watt/c.p. type 1,950 „ 3 „ „
Tungsten	3,200	2,300—2,500
Osmium	2,550	2,250
Tantalum	2,300	2,000
Platinum	1,750	Useless for commercial lamps: running temperature about 1,600 and 1,400° C., respectively.
Palladium	1,540	

as a filament material on account of its low melting point (about 1,700° C.).

It is obviously a matter of great importance to be able to determine the actual temperature of a filament with reasonable accuracy, but the difficulties in the way of so doing are enormous. Temperatures up to 2,000-2,500° C. can be fairly easily and accurately measured when the temperature of a reasonably large mass of material is in question, and when the form of that material is such as to enable the use of thermo-couples without the introduction of conduction errors, &c. In the case of metallic filaments, however, the mass of metal concerned is very small (thus in a 25-c.p. tantalum lamp the total weight of filament is about 0·022 grammes, its length being about 65 cm. (25·6 in.)).

It is impracticable to attach a thermo-couple to a glow lamp filament with any hope of obtaining reliable readings, or rather readings which will represent the normal conditions in the lamp. Apart from the conduction troubles which would arise, the ordinary running conditions of the filament would be quite upset; the radiation facilities and candle-power would be very different from those normally obtaining in the lamp.

Hence it is that all measurements of filament temperature are generally based on some empirical radiation law. Of the many such which have been proposed, probably that due to Stefan is the best known, and, for many purposes, the most reliable. For high temperatures, however, recent research has made it probable that the Stefan law gives rather low values. The simplicity of this law, which is expressed by—

$$W = K T^4, \quad \ldots \quad \ldots \quad (2)$$

where W = watts radiated per cm.^{2} of filament surface; $K \propto 3$ to 5×10^{-12} watt/cm.^{2}; T = absolute filament temperature (°C.), greatly commends it for approximate calculations, but the form of equation—

$$T = \frac{26{,}965}{13{\cdot}02 - \log_e \phi}, \quad \ldots \quad \ldots \quad (3)$$

(ϕ = intrinsic brilliancy of filament in hefners per sq. mm.) based on the average theoretical and experimental results of Rasch, Le Chatelier, Boudouard, Nernst, and Lummer and Pringsheim, gives values which are probably nearer the truth than those obtained from the Stefan equation. To obviate the necessity of evaluating the fraction of equation (3) for each particular value of the intrinsic brightness ϕ, the author has prepared the curves of figs. 2 and 3 (p. 5), which are accurate to about ¼ per cent.

Notwithstanding that various researches, acting to some extent as cross-checks on each other, support the general truth of the law of equation (3), there are such serious difficulties in these high-temperature investigations as to make the results thereof somewhat unreliable. It would seem that accuracy is most to be hoped for by the development of R.-T. (resistance-temperature) laws for the materials of filament construction, these laws to remain true at high temperatures (1,800-2,300° C.). The ordinary resistance-temperature laws, operative up to 400-500° C., are naturally quite untrue at these high temperatures, for which special equations must be experimentally obtained. There are most serious obstacles to the obtaining of these equations, but, once obtained, temperature measurements would be more accurately carried out than is at present possible. Differences in the radiating conditions, the effect of conductivity and convection, and the influence of the nature of the enclosure of the filament would no longer directly affect the temperature estimation. These influences would still have their effect on the actual temperature, but this alteration would be at once allowed for by the consequent change in the resistance of the filament. Moreover, it is a matter of experience that the resistance-temperature law for different samples of a given material is tolerably constant, hence, from a reliable standard research such representative conclusions could be drawn as would enable the construction of a temperature-resistance characteristic for any given lamp, and there seems little doubt that more reliable results would obtain than are at present yielded by radiation formulæ.

(*To be continued.*)

SOME LARGE INDUCTION COILS.

MR. CHARLES W. COX, of 6, Sefton Drive, Liverpool, has sent us particulars of some exceptionally large induction coils which he has recently constructed. Mr. Cox's experience in this work dates back for very many years commencing with a 6-in. coil in 1879; he has now made one 6 ft. long, giving a spark in air of 51 in. The accompanying illustrations show two of these coils, and the details of their construction are given below.

Coil No. 1.—Core composed of No. 30 S.W.G. charcoal iron wires; length of core, 72 in.; diameter, 4 in.; weight, 140 lb. (see fig. 2).

The primary winding is of No. 8 S.W.G. copper wire, 800 turns in all, and weighing 80 lb., arranged for parallel or series. Total

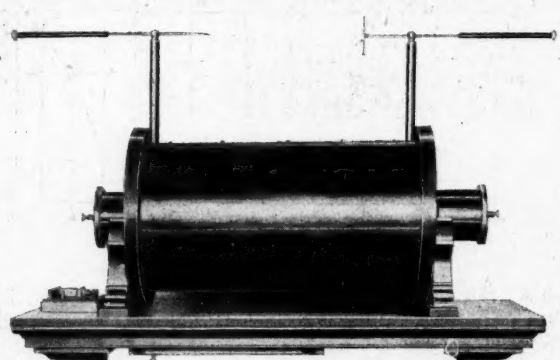


FIG. 1.—30-IN. SPARK COIL.

weight of coil and primary when insulated and ready for tube, 236 lb.

Primary tube of ebonite, 84 in. long, ½ in. thick, weight 32 lb., 5½-in. bore.

The secondary wire comprises:—80 miles, No. 36; 20 miles, No. 34; and 4 miles, No. 32, S.S.C.; total weight of secondary wire, 73 lb.; total resistance, 89,500 ohms; number of turns, 219,000; external diameter, 14 in.; mean diameter of turns, 2·6 in.

The secondary was wound in horizontal layers of four divisions, averaging 66 layers in each. Each section was then moulded solid with beeswax composition, turned in the lathe, and mounted, each on a separate ebonite bobbin. A central ebonite division and two end cheeks carry two outer ebonite tubes, 16 in. in diameter, 36 in. long, and $\frac{3}{16}$ in. thick.

The secondary ends are brought up through thick ebonite tubes, and the whole coil is mounted on ebonite tube stands. Altogether 128 lb. of ebonite was used, the total weight of the coil without stands being 489 lb.

Spark length in air:—With 25 amperes in the primary, 51 in. (2 ohms); with 5 amperes, 30 in. (9 ohms).

The primary current was derived from 230-volt mains. The figures in brackets give the resistance in series with the primary.

The size of the condenser found to give the best results was similar to what was used on a 16-in. spark coil—about ·1 microfarad—but very special precautions had to be taken with the dielectric, and it was only after several failures that a condenser was made which would stand.

Above 30 in. spark, again, or rather when using currents above 5 amperes, the ordinary turbine breaks gave trouble, and could not be used to get the maximum spark discharge. A mechanical break without mercury and revolving with extreme rapidity, but having a contact duration of five-sixths the revolution, was found best. There is no doubt, however, that very special apparatus is necessary to interrupt such a circuit at the speed one wants to work at.

In working with the coil it was found necessary to keep the dischargers well separated, and not to allow a flame discharge. When this happened, whatever distance the dischargers were apart, the current rose rapidly in the primary, the flame acting almost as if short-circuiting the secondary.

The long-distance sparks were very brilliant and noisy. When running with a 30-in. spark and about 1,000 interruptions per minute, the effect was very fine, especially the intensely thick white spark occurring every second or so, which apparently is a condenser effect superimposed on the disruptive spark. This phenomenon is common to all coils, but was extraordinarily brilliant in this case.

Coil No. 2. 30-*in. Spark.*—This coil is one of two, the other being as yet unfinished; it will have, however, the same spark length, with a lower resistance secondary.

The instrument illustrated (fig. 1) has a core of No. 30 iron wire 36 in. × 3½ in., the primary being two layers of No. 10 S.W.G., wound in two layers arranged for either series or parallel. Total weight, with ebonite tube 44 in. × 6 in. × $\frac{3}{8}$ in., 99 lb. The secondary consists of 40 miles No. 36 S.W.G., 16 miles No. 38 and 2 miles No. 32. Total turns, 122,000; diameter, 13 in. The secondary is wound on two ebonite bobbins, which slide over the primary tube, and are readily dismantled if it is required to move the coil. The finished diameter is 14½ in., including the outer ebonite tube. Diameters of cheeks, 16 in.; total weight of coil, 208 lb. On test there was no difficulty in obtaining a 32-in. spark with 15 amperes.

When mounted, the dischargers cannot be separated more than 29 in., at which distance a torrential discharge takes place, using a turbine break at 3,000 R.P.M.

The small amount of secondary wire (33 lb.) is noticeable for a coil of such a size, but, of course, the resistance is high—59,000 ohms. The sparks, however, are magnificent, and a fine flaming discharge can be obtained up to 24 in.

The discharges through large tubes of high vacua show very beautiful striæ effects. Of course, any size of focus tube can be used. An 8-in. tube shows very fine definition for screen work with about 4,000 interruptions and 5 amperes.

Coil No. 3 has a very low resistance secondary, being wound with No. 34 and No. 32 S.W.G., or what is now called an "intensified" coil. The primary is of flat strip copper $\frac{3}{8}$ in. × $\frac{3}{32}$ in., wound two layers in series. It requires 25 amperes to give the maximum spark of 20 in., but it can be used up to 40 amperes for short periods. The flame discharge is intensely hot. The coil was built for X-ray photographic work.

It will be noticed in the description of the winding of these coils that various gauges of wire have been used in the secondaries, and it may be stated that in practice it is found advisable to use a heavier gauge as the winding approaches the ends. Theoretically, the current in the secondary should be constant throughout its length, but there are evidently other factors, especially in connection with the condenser capacity of the secondary itself, which make it certain that the wire has to do more work as the terminals are approached. Many of the early failures with large coils have been due to the secondary being too fine at the ends.

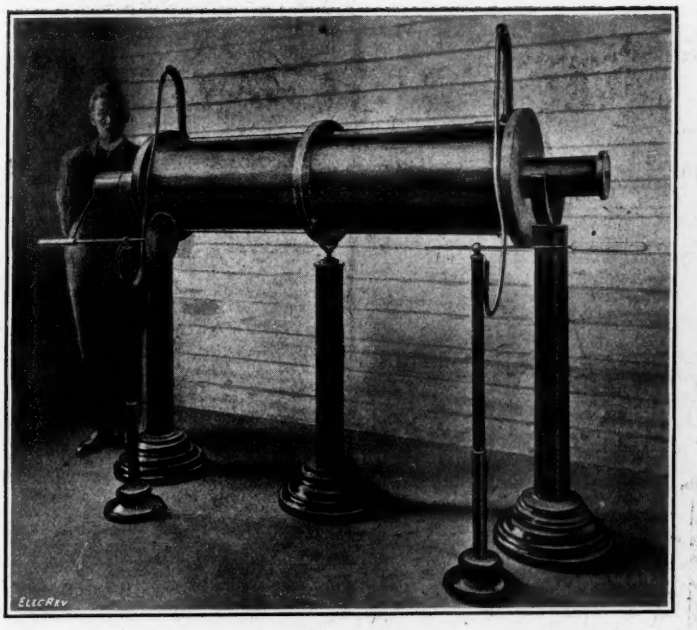


FIG. 2.—51-IN. SPARK COIL.

THE PHYSICAL SOCIETY'S EXHIBITION.

(*Continued from Vol.* 65, *page* 1079.)

Weston Electrical Instrument Co.

The Weston Co. had a striking exhibit of their switchboard and portable instruments, of various types, for A.C. and D.C., portable testing sets, speed indicators, &c.

FIG. 19.—FOOL-PROOF GALVANOMETER.

Synchronome Co.

This exhibit consisted of a variety of the firm's electrically driven pendulums and impulse dials, the latter operated at intervals of 1, 2 or 30 seconds. Further improvements have been made in this well-known system, tending to greater accuracy. The working of the system has been examined with the aid of the oscillograph, and a number of records were exhibited showing the effect of varying conditions of voltage, self-induction, &c.

Gambrell Bros.

A remarkable feature of this exhibit was a "fool-proof" galvanometer, with suspended moving coil (fig. 19). The liability of this type of galvanometer to be put *hors de combat* by careless handling has hitherto been a great drawback to its otherwise admirable qualities; but Messrs. Gambrell Bros. have succeeded in eliminating this defect, and the galvanometer illustrated can even be dropped on the floor without injuring the suspension or movement, though naturally this mode of testing is not advocated by the makers. The instrument is of the iron-core pattern, with a well-aged magnet, shaped to give proportional scale readings, and the scale is provided with an anti-parallax mirror. A special feature is made of the suspension strip, which will support 100 times the weight of the movement. It will be noticed that levelling screws, being unnecessary, are not provided.

The galvanometer can be had with pointer alone, or with mirror as well, as illustrated; it gives a deflection of one degree through a megohm with 1·4 volts.

Fig. 20 shows the firm's latest pattern of direct-reading Wheatstone bridge, in which all the parts are enclosed in a dust-proof box; the resistances are arranged in dial form, with laminated phosphor-bronze contact arms, a type which the firm has had under observation for over two years, and has proved free from error due to variation in contact resistance.

The working parts are mounted on an ebonite slab, and are well insulated from the polished mahogany cover; the keys are also

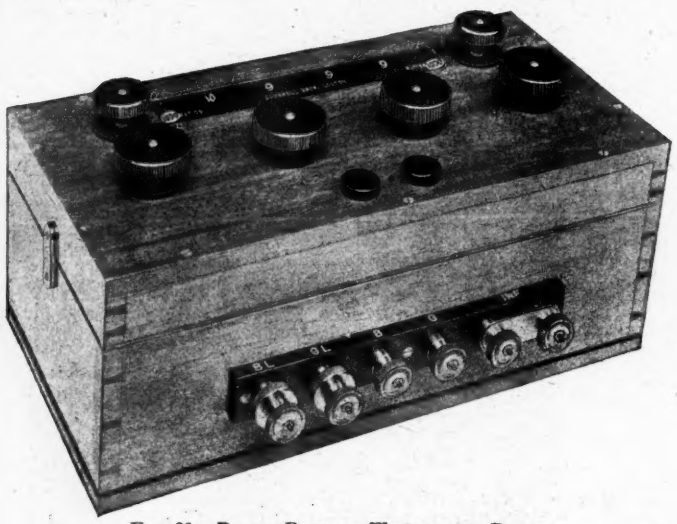


FIG. 20.—DIRECT-READING WHEATSTONE BRIDGE.

dust-proof. All parts are readily accessible when the box is opened, by unscrewing two brass straps. This pattern of box has many advantages over the plug pattern, in respect of quick working, freedom from mistakes in reading, and the elimination of the errors due to loose or dirty plugs.

A variety of resistance boxes of other patterns was shown, as well as apparatus for students' use, lantern demonstrations, &c.; and a number of high-class moving-coil galvanometers of the firm's

FIG. 21.—SENSITIVE MOVING-COIL GALVANOMETER.

latest patterns, of which fig. 21 is an example. This galvanometer is especially suitable for high-class work, such as cable testing, though it is readily portable; the suspensions can be interchanged, giving various sensibilities, and the galvanometer can be used for ballistic work if desired. The usual sensibility is about 1,000 mm. at one metre per micro-ampere.

Nalder Bros. & Co.

The principal item of this exhibit was Duddell's patent bifilar vibration galvanometer, the design of which follows the lines of the Duddell oscillograph, with the essential difference that in the former the damping is reduced to a minimum. The instrument is illustrated in fig. 22; it can be tuned to any frequency, from 100 to 1,800 cycles per second, by altering the tension and length of the vibrating wires, and has a sensibility of 40 or 50 mm./m. per microampere at a frequency of 100 cycles. Owing to the special design of the instrument, its inductance is extremely small, and

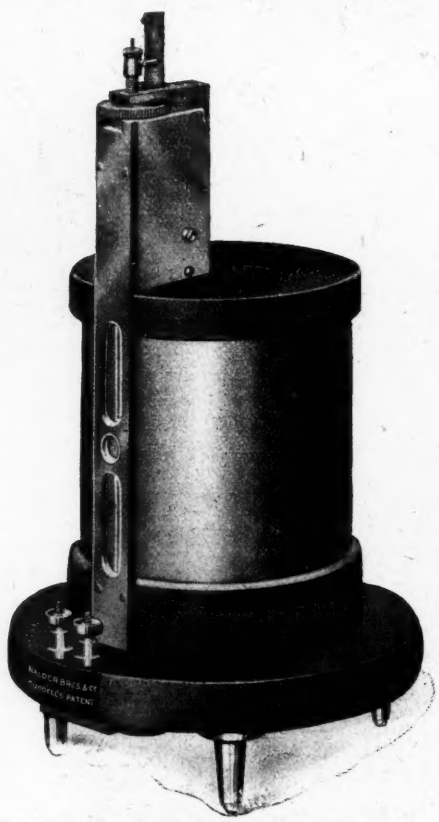


FIG. 22.—DUDDELL BIFILAR VIBRATION GALVANOMETER.

the back E.M.F. set up by its action is also comparatively small. The resistance of the instrument is from 100 to 140 ohms.

Other exhibits included the Mansbridge patent variable standard of self-induction, having a range of from 0·7 to 105 millihenrys; a new type of d'Arsonval galvanometer; portable testing set, potentiometer, &c.

Cambridge Scientific Instrument Co., Ltd.

This company had a very large exhibit of apparatus of various descriptions. The Féry radiation pyrometer was shown in a greatly improved form, the E.M.F. of the thermo-couple having been increased so that a pivoted milli-voltmeter can be used instead

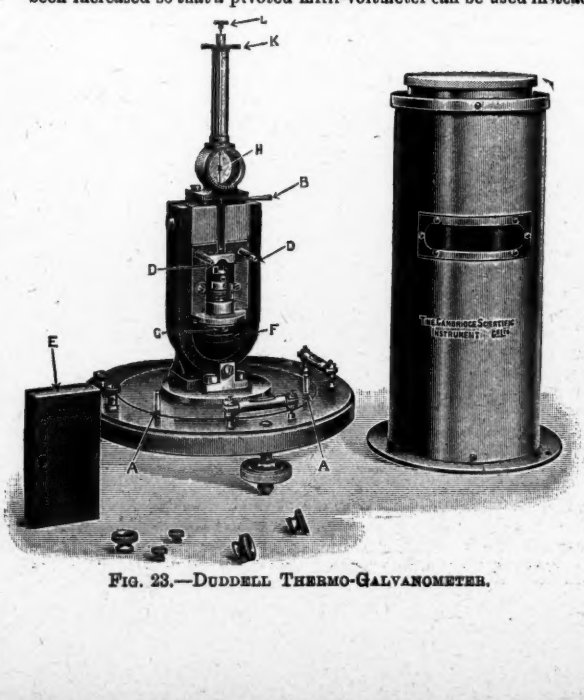


FIG. 23.—DUDDELL THERMO-GALVANOMETER.

of a suspended-coil instrument. The Féry spiral pyrometer was also exhibited; in this instrument a tiny bimetallic spiral is used, actuating a pointer, instead of the thermo-electrical system of indicating the temperature. Mercury thermometers (Hohmann and Maurer type, fig. 27) specially designed for ascertaining the

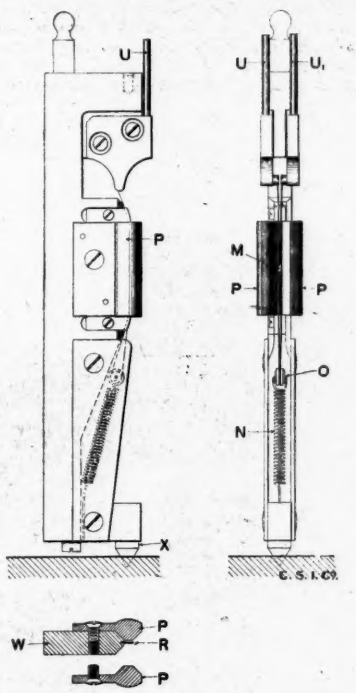


FIG. 24.—VIBRATOR OF DUDDELL OSCILLOGRAPH.

temperature of steam, feed water, &c, with improved sockets, which give greatly increased sensibility to rapid changes in temperature, were other interesting items, and there were many others not directly appealing to electrical men.

receiving aerial in wireless telegraphy, can be measured. The illustration shows the instrument in its latest form, fitted with a heavy copper case instead of the old mahogany cover, to prevent the existence of temperature gradients inside the case, which would affect the zero.

In the new pattern of Duddell oscillograph, each vibrating loop of strip is now built up as a complete unit, these units being separately removable and interchangeable. Fig. 24 illustrates the present type of vibrator. Referring to this figure, W is a brass frame which supports the two soft iron pole-pieces, P, P; between P and P is a long narrow groove divided into two parts by a thin soft-iron partition, R, which runs up the centre of it. The current being led in by the brass wire U, passes from an insulated brass plate to the strip, which is led over an ivory guide-block, down one of the narrow grooves and over another guide-block, then loops round the ivory pulley O, which puts tension on the strip by the spring N, back to the guide-block again, up the narrow groove, and out by way of the insulated brass plate and lead U. Half-way up the grooves the centre iron partition R

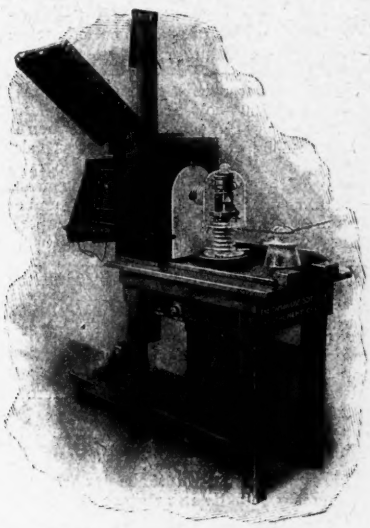


FIG. 26.—COMPLETE OSCILLOGRAPH WITH PHOTOGRAPHIC ATTACHMENT.

FIG. 27.—H. AND M. THERMOMETER WITH SEPARABLE SOCKET.

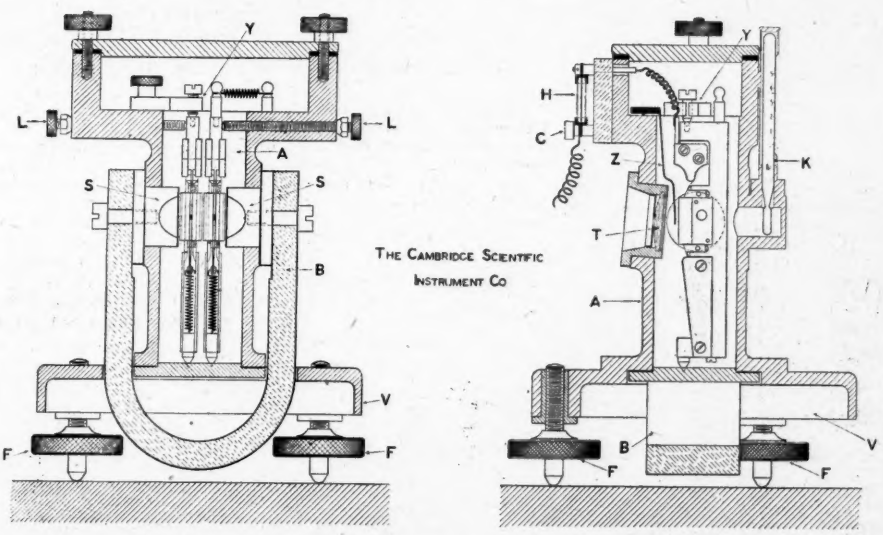


FIG. 25.—SECTIONAL VIEWS OF PERMANENT-MAGNET OSCILLOGRAPH.

A new pattern of the Duddell thermo-galvanometer was shown, which we illustrate in fig. 23, p. 8. This instrument has practically no self-induction or capacity, and can therefore be used with currents of any frequency attainable, while its sensibility is so great that a current of 20 micro-amperes can be measured. The moving system consists of a Boys radio-micrometer—a loop of silver wire, the lower ends of which are connected to a minute thermo-couple—suspended from a quartz fibre in a strong magnetic field; a tiny heater of platinised quartz fibre is fixed immediately under the thermo-couple, and is traversed by the current to be measured.

The heater is straight, and only 3 or 4 mm. long; yet it may have a resistance of 1,000 ohms, if desired. The period is short—3 or 4 seconds—and the instrument is unaffected by external magnetic fields. With this galvanometer the currents generated by speaking into a telephone receiver, or those set up in the

is partially cut away to permit of a small mirror (0·3 × 1·0 mm.) M, bridging across from one strip to the other, being stuck to the strips by a dot of shellac at each corner. The vibrator illustrated is the type used in the Duddell permanent-magnet oil-bath oscillograph, and in this type the pole-pieces P, P, are removable for ease in repairing. Two of these vibrators are placed side by side in the gap between the pole-pieces S, S, of the permanent magnet illustrated in fig. 25. This illustration gives two sectional views at right angles through the permanent-magnet type of oscillograph. Each vibrator is pivoted about vertical centres, the bottom centre fitting in the base of the oil bath, and the one at the top being formed by a screw in the cock-piece Y. It can thus be easily turned in azimuth, its position being fixed by the adjusting screw L; a spiral spring serves to keep the vibrator always in contact with this screw. Since each cock-piece can be indepen-

dently moved forward or backward, each vibrator can be tipped slightly in either of these directions, so that complete control over the mirrors is obtained and the reflected spots of light may be made to coincide with that reflected from the fixed zero mirror, which is fixed to a brass tongue between the two vibrators.

A plano-convex lens T, of 50 cm. focal length, is fixed in the oil bath in front of the vibrator mirrors to converge the reflected beams of light. It will be seen from the illustration that this lens is slightly inclined, so that no trouble will be given by reflections from its own surface.

The normal distance from the vibrator mirrors to the scale or photographic plate is 50 cm., and at this distance a convenient working deflection on each side of the zero line is 3 to 4 cm. This is obtained with a R.M.S. current through the strips of from 0·05 to 0·1 ampere, according to wave form, &c.

One of the advantages of this new design is that the vibrating systems are completely immersed in oil, and as long as the top of the oil bath is kept screwed down, the instrument is perfectly air-tight and dust-tight. The instrument is, therefore, ready for use at any time, and does not require refilling with oil at frequent intervals, as was necessary with the older pattern. In the high-frequency electromagnet pattern, the natural free period of the vibrating loop is $\frac{1}{10000}$ sec., but in the permanent-magnet type illustrated the natural free period is $\frac{1}{3000}$ sec. Fig. 26 illustrates the complete falling-plate camera outfit with permanent-magnet oscillograph mounted for use on a 25,000-volt circuit. The photographic plate falls freely under gravity down the slide, and when it has attained a speed of about 400 cm. per second, it passes a slit through which the vibrating beam of light from the oscillograph passes, tracing out the curve on the falling plate. By this means one or two consecutive wave forms are recorded, but when a number of consecutive wave forms are required, as in cases where experiments are being made on resonance effects, it is necessary to use a cinematograph camera in place of the falling plate. The makers have recently supplied a somewhat similar outfit specially insulated for use on a 50,000-volt circuit.

Amongst other exhibits were Dr. Drysdale's slip meter, the Abraham rheograph, pressure gauges, &c. The Einthoven string electrometer was shown; this is similar in principle to the string galvanometer, which is now being used for wireless telegraph work as well as for medical electricity, enabling a photographic record to be made of the signals received.

Reason Manufacturing Co., Ltd.

This firm exhibited a Wright patent electrolytic meter arranged to show the deposition of mercury actually in progress, a temperature-compensated meter for laboratory use, and a pretty little one-ampere-hour Wright meter for use in test rooms, one division of the scale representing a consumption of 0·01 A.H. An electrically-driven clock of novel design was also shown, which would go for two years with one pair of dry cells to work it.

(To be concluded.)

NEW ELECTRICAL DEVICES, FITTINGS, AND PLANT.

Electric Lamp Cleaner.

The rapidity with which the bulb of a lamp becomes obscured, and the rarity with which, as a rule, it is cleaned, must have been observed by most of us. To remedy this trouble with ease and

Fig. 1.—Save-Time Lamp Cleaner.

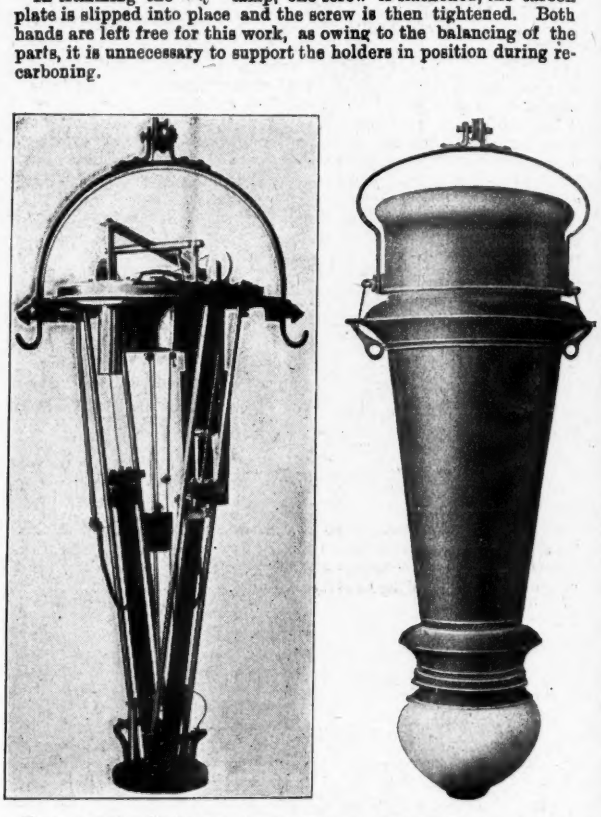
without breaking the filaments of tungsten lamps, Messrs. Garty, Bone & Co., of Anderston Electrical Works, Glasgow, have brought out a neat little device which they call the "Save-time" electric lamp cleaner. We illustrate this in fig. 1, which is self-explanatory. The cleaner, as we can testify from practical trial, is quite effectual. To reduce the danger of breakage of filaments to zero, it is advisable to clean the lamp while it is burning, as the filaments are far more fragile when cold than when incandescent.

The "Q" Flame Arc Lamp.

The chief disadvantage of the earlier flame arc lamps was the frequency with which they had to be trimmed. The Foster Arc Lamp and Engineering Co., Ltd., of Wimbledon, have overcome this obstacle by an ingenious device. Four carbons are moulded side by side, and together form one plate; two such plates are used—one for each pole. On switching on the current, the arc strikes across the ends of the carbon plates. As the carbons burn away the arc travels to a further spot, and gradually travelling backwards and forwards, consumes the carbons evenly. Owing to the large cross-section of the plates, it is unnecessary for metal cores to be used. The shape of the carbons, too, adds considerably to their mechanical strength. We understand that the cost of carbons per burning hour is only 0·18d.

The accompanying illustrations, figs. 2 and 3, show the general appearance of the Foster Arc Flamer and the simple carbon arrangements.

In trimming the "Q" lamp, one screw is slackened, the carbon plate is slipped into place and the screw is then tightened. Both hands are left free for this work, as owing to the balancing of the parts, it is unnecessary to support the holders in position during re-carboning.



Figs. 2 & 3.—Interior and Exterior of "Q" Flame Arc Lamp.

The lamp, which can be supplied for either direct or alternating-current, works on an improved brake-wheel principle. The mechanism, which is very simple, is totally enclosed in a cast-iron case fixed to the top of the lamp. No fumes can get inside the lamp, owing to the ample and very efficient ventilation, which is in a downward direction through the case, the heated gases being discharged near the edge of the globe.

Messrs. Foster state that they supply the "Q" type flamer for three periods of burning: 15 hours, 25 hours and 45 hours. Every lamp is made throughout in their Wimbledon works, and the most stringent tests are enforced before any apparatus is sent out.

PARLIAMENTARY.

Devonport Tramways.—The Bill which the Devonport and District Tramways Co. has deposited in the Private Bill Office contains proposals for amending the company's Act of 1898 and certain agreements between the Corporation and the company. From the preamble of the Bill it appears that the company was incorporated in 1898 and had constructed certain tramways in the borough. In 1899 the Corporation also obtained powers to construct tramways, and under their Act of that year and subsequent years had constructed tramways. In 1902 an agreement was made between the Corporation and the company, by which the company took a lease of the Corporation tramways for a term of 28 years from 1898. The company agreed to pay to the Corporation the following rents:—(*a*) £2,176 6s. 8d. per year, being a sum calculated at the rate of £3 10s. per cent. per annum on the capital expenditure (£62,180 18s. 10d.) of the Corporation on their tramways; (*b*) £1,306 19s. 11d., being such an equal annual sum as would with the accumulations thereof by way of compound interest at the

rate of £3 10s. per cent. per annum, be sufficient to redeem and pay off the capital expenditure within a period of 30 years, with the proviso that the reasonable cost of the concrete on the Camel's Head Embankment, and of improving the gradient of Milehouse Hill, should be added to and form part of the capital expenditure for the purpose of computing Rents "A" and "B"; (*c*) £213 11s. 1d. per year, being a yearly rent computed at the rate of £50 per mile of route of the Corporation tramways; and (*d*) the annual sum of £200, being a contribution during the residue of the continuance of the said term to the cost of reconstructing Camel's Head Bridge. The company were also required by an Act of 1898 to take their supply of electricity from the Corporation, and the rate was fixed by Major Cardew as arbitrator in 1902. The result of the working of the tramways by the company has been that the earnings have been insufficient for them to pay the rents agreed upon, and it is proposed by the Bill that in lieu of Rents A and B the company shall, during the continuance of the lease, pay to the Corporation the whole of the net revenue accruing from the Corporation tramways in each separate year, after deducting from the gross receipts arising in each year from such tramways, the expenses as nearly as they may be ascertained of the management, working, maintenance, repairs, renewals and depreciation, &c., of the Corporation tramways. The company also seek to be relieved of all liability which the Corporation may incur in respect of the Camel's Head Embankment and the gradient of Milehouse Hill, and further, to be relieved of the liability to pay Rents "C" and "D." It is also asked that the paragraph in the lease to the effect that on the expiration of the term the undertaking shall be handed over to the Corporation without payment, shall be cancelled, and in lieu thereof it shall be enacted that at the expiration of the lease the Corporation shall be required to pay fair value for the rolling stock owned by the company. As to the supply of electrical energy by the Corporation, the company seek to enact that after June 13th, 1911, the price to be paid shall, in the event of any difference arising between the Corporation and the company, be such sum as shall be determined by the arbitrator to be equal to the cost incurred by the Corporation in respect of the production of such energy, with the addition of 5 per cent. thereto. It is also intended to appoint the British Electrical Federation, Ltd., as directors of the company.

Mersey Railway Bill.—By the Mersey Railway Act of 1898, to facilitate the raising of certain capital the payment of interest on the already issued debenture stock was made contingent till 1905 on the revenue available in each separate year, and in 1906 the period was extended till 1910. It is pointed out that the company have now equipped the railways for electrical working, and the result has been a substantial increase of traffic, and by the Bill it is, therefore, asked that the period should be further extended for five years.

Great Northern and City Railway Bill.—It is already understood that this Bill will not be proceeded with. The object of the Bill was to extend the time for the completion of the railway and subway authorised by the Act of 1902.

CORRESPONDENCE.

Letters received by us after 5 P.M. ON TUESDAY *cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.*

The Heurtley Test and Cable-Fault Localisation.

Recent absence from England on cable work, followed by a return home on the very eve of Christmas, affords, I trust, valid excuse for my delay in replying to Mr. E. S. Heurtley's letter published in the ELECTRICAL REVIEW of December 24th.

Mr. Heurtley's letter contains interesting and just criticism of—it is true—only one assertion in a whole series of articles; but the matter is important, and I am glad Mr. Heurtley has taken it up. Also, I express my regret to you, Sirs, and to your readers, for my unaccountable *lapsus mentis* in alleging—in a certain concrete example—that the cause of the 19 ohms discrepancy was due to water-column resistance on the R side of the Wheatstone balance instead of at *x*.

I am sure that the extra resistance of 19 ohms in the above particular example from actual practice was due to water-column effect, and *that* was at the back of my head when I mentioned the water column. By an unfortunate kink in connecting cause and effect, I reversed the position of the extra resistance.

In point of fact, the water column primarily existed in the small perforation (approx. 1 sq. mm.) in the gutta-percha at the fault, and it was this salt water column—probably impregnated, as Mr. Heurtley has suggested, with CuCl deposit—that brought about the extra 19 ohms in the balance at R.

These facts, however, do not affect the advisableness—by me suggested—of having in close proximity to the artificial exposure, an artificial equivalent of the cable sheathing. In practice, this may consist of a helix of iron binding wire through the circular convolutions of which the core bearing the artificial exposure may be conveniently made to pass, both, of course, being immersed in water as similar as possible to that in which the real cable-fault is supposed to lie.

Mr. Heurtley's remarks on the practical effect of an earth current on the ratio of two different testing currents—that is to say, how a ratio nominally *so much* may become, in presence of a telluric current, something very different—corroborate paragraphs 4, 3 and 2 from the end of the writer's article in the ELECTRICAL REVIEW of November 19th, 1909, but Mr. Heurtley's application of these facts to the conditions accompanying his test constitutes an interesting and valuable addition to the hitherto known data relating to this method.

Possibly it might be thought that the practical example—involving serious discrepancy instanced by the writer in the ELECTRICAL REVIEW of November 19th had been given as a normal specimen. That this was far from being the intention of the writer, perusal of the various examples in the context will afford ample proof. This particular example was mentioned in order, if possible, to draw comment from Mr. E. S. Heurtley himself, of whose whereabouts the writer had then no certain knowledge, and the writer is much obliged to him for the trouble he has taken in this matter.

Mr. Heurtley refers to his test as having been re-devised by him some years ago. The writer can claim acquaintance with it (as Heurtley's) for almost a similar length of time, and has heard arguments advanced concerning it, *pro* and *contra*. As, personally, the writer is greatly interested in this method, and in view of the fact that, as far as he is aware, no mention of the Heurtley method and formula has yet been made in any of the text-books, the writer wished to make good the omission. This he has done by the inclusion of the test—with special regard to graphs—in the recently-published series of articles under the heading, "Cable-Fault Localisation Graphs in Practice."

E. Raymond-Barker.

Wimbledon, *December 30th*, 1909.

The Industry and the Institution.

I have been travelling abroad for several years now, and have often wondered why it is that there is apparently no purely British firm that has attained either to the size or success of our American and German competitors. The reason you give in your leading article of last week is that "the principal (German) examples have developed rather as a result of Fiscal conditions than from purely economic causes," which would lead one to suppose that Fiscal conditions are responsible for the fact that these German companies are so successful that they are paying such dividends as 18 per cent., 13 per cent., 12 per cent., and 10 per cent., whereas there is no English company of a similar size that pays its way, and those smaller companies who are struggling to compete with these enormous Continental works have to be content with the reduced dividends or to continue working at a loss.

Till I read your article the explanation was difficult, but you make it quite clear that it is Fiscal conditions which are responsible for such continued satisfactory results abroad and such unfortunate conditions at home.

You may not think it worth while publishing this letter, as I am afraid my conclusions differ somewhat from those of the REVIEW, but I enclose my card.

E. W. A.

Redbournbury, St. Albans,
December 28th, 1909.

The Use of Electricity in Coal Mines.

As president of an important Section of the Institution of Mining Electrical Engineers, and, as I believe, in a more independent position than the great majority of the members of the Institution, I beg to heartily endorse the views set forth in your leading article.

May I point out, also, that when the Report of the Departmental Committee on the Use of Electricity in Mines was issued, with the very large number of rules that accompanied it, I, at the suggestion of the late secretary of the Institution of Mining Engineers, Mr. Walton Brown, reduced the proposed rules to six, which I submit, covered all the requirements of the service. The principle upon which I based the rules was that which you have set out in your article, viz., that you cannot go into details in a matter of this kind, you cannot bind men to detail, but you can bind men to carry out reasonable precautions in a proper manner, if you make them responsible. As you have pointed out, the whole question turns upon responsibility. It is absurd to make the agent, for instance, of a group of mines responsible for details such as those upon which the recent prosecution in Scotland was founded, and, at the same time, not to make the man who is in charge of the apparatus also responsible.

As you are aware, also, the recently formed Institution of Mining Electrical Engineers has for its primary object the raising of the status of electrical engineers engaged in mining work, with the express view of placing responsibility upon them. A perusal of the thoughtful and able inaugural address of our president should, I think, convince any reasonable thinking man that the objects of the Institution are such as deserve support, and that if the Institution be only given fair play it will do very valuable work.

As you rightly remark, and as I have pointed out on more than one occasion, in contributions to the *Transactions* of the Mining Institute, earthing in a mine is an exceedingly difficult matter. Further, as you will be aware, I have persistently opposed the use of armoured cable in mines. My view has been, and is, that the money spent on armour would be of very much more value if spent on insulation or non-conductive material for the protection of insulation. An unearthed armoured cable is a danger, and it is an exceedingly difficult matter to maintain earth at every part of an armoured cable in view of breakages.

At the time when the Departmental Report was issued I referred to the case of ventilation and the manner in which it has been dealt with by the same Department that is dealing with the use of electricity. Ventilation is of far more importance in mining work, and particularly in coal mining, than the use of electricity. The Home Department does not endeavour to check every little detail of the ventilation. It does not oblige fan engines to be fixed in a particular way or in a particular manner. It does not oblige roads to be laid out in a particular way or of a particular size. What it does lay down is that a certain quantity of air shall be forced through every part of the workings per minute, the quantity of air being sufficient to quickly dilute any gas that comes away from the face of the coal, and to maintain a a healthy atmosphere for mine workers. I maintained at the time, and I am with you, in what I believe is your contention, that a similar course would be the proper one for the Department to take in dealing with the use of electricity. Let it be laid down that the insulation, for instance, which is largely the crux of the whole problem, shall be maintained in every part of the service, and leave the responsible engineer to do it in the way he finds best, and similarly with other points.

Sydney F. Walker.

Bath, *January 3rd*, 1910.

Methods and Practice in the German Electrical Industry.

I am unaware if you will allow the discussion to be continued in your columns which has been started by Mr. Bruce Anderson's interesting letter in your current issue. If you do, may I be allowed to make a few remarks in connection therewith.

In the first place, may I suggest that Mr. Anderson's letter would have been of yet greater interest if he had dealt with a particular branch of the industry of which he had intimate knowledge; for example, he might have shown what advantages would accrue to the English manufacturer of, let us say, electric meters by the adoption of a protective tariff, and especially, perhaps, how an export trade in this line would be benefited.

Mr. Anderson has contented himself, however, with two general statements, viz. :—

1. "Our unemployed are increasing every day."

2. We are living "to a very large extent upon our income," this being proved by the fact that "we import 150 millions annually more than we export."

Now, as regards statement (1), it is not necessary to say anything further than that it is inaccurate, as anybody can discover by referring to the official returns of unemployment of this and other countries.

With reference to statement (2), it is necessary to remember three things, as follows :—

(*a*) Our foreign investments amount to 2,700 millions, which at 5 per cent. interest, bring in a return of 135 millions annually.

(*b*) Our mecantile marine earns every year from foreign countries 88 millions.

(*c*) The carriage paid in this country upon our imports amounts to 32 millions annually.

Adding these three items together, we get the sum of 255 millions receivable each year by this country from foreign sources.

Now, I suppose Mr. Anderson will admit that the only way this amount of wealth can come into the country is in the form of goods. Against this has to be set the amount which represents our reinvestments abroad, which, again, can only go out of the country in the form of goods. Mr. Anderson's figure for the excess of annual imports over exports is somewhat too high; it should be 125 millions. Subtracting this amount from the amount receivable, we get the sum of 130 millions annually as re-investments of this country abroad. We thus arrive at the result that we are increasing our foreign investments by an amount at least equal to the interest upon our foreign investments. While I do not profess to be a political economist, yet it seems to me that these figures dispose of Mr. Anderson's suggestion that we are living largely upon the interest of our foreign investments. Perhaps Mr. Anderson can suggest another explanation.

Zähler.

Birmingham, *January 3rd*, 1910.

Ozone.

I have read with great interest the article on ozone appearing in this week's journal. As you are aware, I have for some years been endeavouring to attract the attention of the electrical trade to the various uses of ozone, and the possibilities of making it a profitable branch of their business. I can only suggest that the trade generally must be in too flourishing a condition to warrant the members of it spending their time in investigating the merits of the various applications of ozone.

There is no doubt that your contributor has followed the developments of the subject with very great care, and he appears to be *au fait* with most of the recent developments.

On the highly technical points, however, your compositor has, no doubt, misread his copy, or possibly your contributor's figures were not easily decipherable. For instance, he states that "Sea air contains from 3 to 5 per cent. of ozone." This is manifestly an error, such as is described above.

The maximum amount of ozone found on the sea and on the tops of mountains is in the neighbourhood of one and a half parts per million by volume. It has been found also that the air on the tops of high mountains is richer in ozone than that on the sea.

I think it would puzzle your contributor to find the slightest trace of natural ozone either in a sick room or any other room in a town. Again, the figures given by your contributor for the conversion of oxygen into ozone are somewhat too high. The maximum amount of ozone obtainable from air under the best conditions is about three parts per 1,000 by volume of air, or say 1½ per cent. of oxygen. No doubt your contributor intended to state 10 to 12 parts per 1,000, instead of per cent.

I may say that I am able to bleach most vegetable oils by a strength of ozone of about one two-hundredth part of that mentioned by your contributor.

The statement that there is not any satisfactory chemical test for ozone is absolutely incorrect. The test for ozone is

not only one of the most positive, but one of the most delicate and easiest performed tests known to chemists.

It is possible to measure the amount of ozone contained in a mixture of air to the accuracy of half part per million by volume. Not only can this be measured easily, but the measurement will be absolute.

I have for many years been working on this question of tests for ozone, and I have now designed a set of tests whereby it is possible to measure to the accuracy I have stated above and to carry out the test and measurement in a few minutes, compared with what used to take me many times that length of time.

I shall be very glad to see your contributor or any other of your readers at this address, and to show them what is being done in this country with ozone. I am under the impression that I might be able to considerably astonish your contributor.

Edward L. Joseph,
Managing Director of Ozonair, Ltd.

London, S.W., *December 31st*, 1909.

FUEL SUPPLY CONTRACTS ON A HEAT-UNIT BASIS.

By JOHN B. C. KERSHAW.

The issue of the Electrical Review for September 24th contained an editorial article entitled "Buying Coal for What it is Worth," summarising the information given in one of the American weekly technical journals as to the progress in that country of the movement for purchasing fuel upon a British thermal unit basis. This movement, it must be admitted, is making much more rapid progress in America than in our own country—a fact which is due, partly to the Government sanction and support which the new method of purchase has received in the United States, and partly to the much greater readiness of the average American fuel user to try the new procedure in relation to coal purchase. To analyse and discuss at length the causes of this latter phenomenon would lead the writer too far from the subject of the present article, but he may be allowed to express his opinion that this greater quickness of the American is due partly to his training, and perhaps in larger part to his position as a protected manufacturer in one of the largest natural markets of the whole world. He can afford to make large scale experiments, and does so, whenever he obtains the opportunity. The English fuel-user, on the other hand, is conservative by instinct, and timid as regards pecuniary loss. He always desires clear proof that *someone* else has tried the new idea or method *with success*, before he will so much as consider it. This is illogical, because no process attains a real and lasting success until it has survived many failures, and circumstances alter so, that no one success or failure can be taken as any criterion of the results of the next trial. The only real test is that based on personal trial with an unbiased mind to judge the results—and the success of Americans in many directions is due to their constant readiness to try things over again for themselves, without regard for others' failures.

That a few practical difficulties may arise in carrying out this method of fuel purchase, the writer is quite ready to admit, and it is his purpose in this article to discuss these *seriatim*, and to point out how they may be overcome, giving finally the experience of two firms in the North who are now trying the new method with success.

Opposition by Committees.—Electric power station engineers are often hampered in their action by the committees under which they serve, and are unable to adopt fuel purchase upon a heat unit basis, because the Electric Lighting Committee is not convinced it is practicable or desirable.

Opposition of this kind can only arise from one of two causes; it is based either upon ignorance, or upon some special interest in keeping the contract for fuel in the hands of a particular colliery company.

In either case, the conversion of the Committee is simply a question of time, and a tactful engineer with a keen desire to try the new method should be able to win over his Committee to the reformed system of purchase within 12 months. The distribution of literature on the subject, and the strict application of the principle that committeemen should not vote upon contracts in which they have a personal and pecuniary interest, would soon clear the way for the new method of purchase.

Opposition by Colliery Firms and Middlemen.—The objection of colliery companies and agents to the new method of purchase undoubtedly exists, and is more difficult to overcome. It may be fairly argued that if the new method of purchase is to benefit the purchaser it cannot also benefit the seller, and that what the user gains the supplier loses.

Those engineers who sit down quietly in front of this dilemma, and allow it to hinder indefinitely their trial of the heat-unit basis of purchase are, however, lacking in resource. There are few electrical power stations which are tied up irrevocably as regards fuel supply to one particular colliery or supply agent, and where active competition exists this hindrance can be overcome.

It can also be stated with some degree of truth and force, that the new system will benefit the coal producer as well as the consumer. As pointed out in a leading article appearing in a recent issue, one unexpected result of the Eight Hours Mines Act has been to lead to a serious deterioration in the quality of small coal, due to the exercise of less care in the mining operations. It is to the colliery owners' interest that this deterioration should be noted and checked. Now, the regular sampling and testing of fuel supplies will be found the best check upon this deterioration in the quality of our small coal, and this is precisely what purchase upon a heat unit basis entails. This system of purchase also provides a just and reasonable basis for settling all disputes between buyer and seller, and is better and fairer to the producer than the present ones of refusing delivery and declining to renew the contract. These three benefits are not without interest and weight for the colliery companies, and in time no doubt the majority of colliery firms will be quite willing to quote for supplies on the new basis.

The Difficulty of Sampling the Fuel.—The difficulty of obtaining fair samples of the fuel delivered is more real than the difficulties already dealt with, and therefore the subject will be discussed at some length. The sampling of small coal, or slack, is more easily carried out than the sampling of large coal, since a smaller sample can be obtained, representative of the bulk of the fuel. In either case, however, the sample is best taken as the fuel is *being discharged* from the wagon or boat in which it has been transported to the user's works. Samples taken from the wagons or boats *before* discharge are valueless, for the fuel lying on the surface is always of better quality than that below, the difference being due to the shaking of the trucks, and to the cleansing action of any rain to which the fuel has been exposed during the journey from the colliery to the consumer's works.

Where the consumption is on a large scale, and mechanical methods are in use for conveying the coal to the storage bins, it is a comparatively simple matter to arrange an intermediate sampling bin, into which the whole contents of every tenth, twentieth or fortieth bucket are tipped at the discretion of the man in charge of the conveyor. When the discharge of the fuel is carried out by hand labour, and the total amount received per day is small, the samples should be taken by the engineer in charge of the boiler plant after the buckets or barrows are emptied on to the pile of fuel in front of each boiler.

The best method of taking and storing small samples in such cases is to use one of the ordinary covered galvanised iron dustbins sold for house refuse as a storage bin, and to sample each heap of fuel upon which fresh fuel is being discharged with a small hand shovel at half-hourly or hourly intervals while the discharge lasts.

The samples should be taken at equidistant points, on the levels marked A, B, C and D in fig. 1, about one bucketfull of fuel being obtained at each sampling operation. At the end of the day the bin is taken to the place reserved for crushing and reducing the sample, the whole of the fuel is turned out, and a small 1-lb. sample is prepared from it by the crushing and quartering methods described below.

In stations where the amount of fuel consumed per week is large (over 200 tons), a man trained for sampling work ought to be engaged to give his whole time to this duty. In

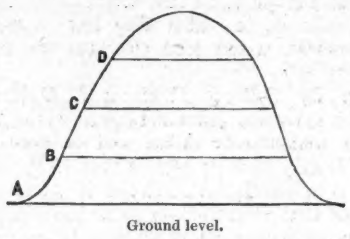


Fig. 1.

smaller stations, the engineer in charge of the boilers can look after it.

The crushing of the fuel can either be performed by hand with a heavy cast-iron stamp or hammer, having a superficial area of at least 144 sq. in., fig. 2, or a mill can be employed for this purpose. A specially designed grinding mill for fuel was described and illustrated in the issue of the Electrical Review for October 8th, p. 572. When larger quantities than 56 lb. have to be crushed, a small mortar mill driven by mechanical means is necessary. After the first crushing, the heap of fuel is thoroughly mixed by

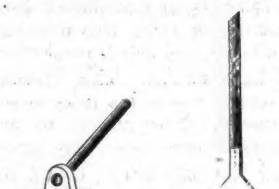


Fig. 2.

turning over and over with a spade. The heap is then flattened down, two lines are made across it at right-angles with the edge of the spade, and two of the four opposite sections are selected to form the reduced sample. The lumps in this are again crushed, the sample is again mixed, and the quartering operations repeated, until about 8 or 10 lb. of fuel only remain, with no lumps that will not pass through a $\frac{1}{4}$-in. sieve. Two 1-lb. tins, with patent lids, are then filled from this remaining heap of fuel, after thoroughly mixing the latter with a small shovel.

The preparation of the sample should be carried out in a room or place set apart for this purpose, at a considerable distance from the boilers, in order that it may not be overheated, and thus liable to cause alterations in the moisture contents of the fuel. Should no proper sampling plate be available, four or more of the iron plates used for covering man-holes in the flues may be utilised in order to obtain a clean and hard surface on the floor of the room, upon which the mixing and quartering of the sample can be carried out.

Samples of the deliveries of fuel taken in this way are thoroughly reliable, and the system can be varied to suit all requirements by lengthening the interval between successive sampling and crushing operations.

One of the firms purchasing fuel on the heat unit basis in South Lancashire, takes daily samples of the deliveries of fuel, but only crushes these samples once every fortnight, and the adjustment of price is thus made on two tests per month. Another firm purchasing on the same basis, takes samples from the stacks tipped opposite each boiler at irregular intervals once each week, and crushes and reduces these samples immediately after taking. In this case, therefore, four samples per month are obtained.

The Adjustment of Price to Quality.—The tests required for the monthly price settlement are moisture, ash and calorific value. Provided with these figures for these tests, the purchaser is in a position to work out the delivered value of the fuel, employing either one of the methods referred to in the Electrical Review leading article on September 24th, or one about to be described.

The latter method is based on that used by the Fuel Engineering Co., of Chicago, and it has been described quite recently by the writer in an article published in the *Engineer*, from which the following extracts are taken :—

"The net value of the fuel from the purchaser's point of view is represented by the B.TH.U. which can be purchased for one penny. This value is obtained in the following way :—

"The B.TH.U. per lb. of dry coal is diminished by the number of B.TH.U. corresponding to the moisture, since, if the fuel contains 5 per cent. of moisture, there can only be 95 lb. of dry fuel in every 100 lb. of fuel as delivered. The figure obtained after making this deduction represents the B.TH.U. in 1 lb. of the wet fuel ; this is multiplied by 2,240 to give the B.TH.U. in 1 ton of the fuel, as delivered. Having obtained in this way the total B.TH.U. contained in 1 ton of the fuel, it is only necessary to divide this figure by the price of the coal, expressed as pence, in order to obtain the net B.TH.U. per penny of cost. Before doing this, however, the price per ton as delivered is increased by an amount in pence, equal to one-fourth of the ash percentage, in order to compensate for the decreased burning efficiency of the coal due to this cause.

The following formula is the algebraic expression of the above calculation :—

$$\text{C}\,g = \frac{\{\text{H}\,d - (\text{H}\,d \times \text{M})\} \times 2.240}{\text{P} + \frac{\text{A}}{4}}.$$

C g = contract guarantee, or heat units for 1d.
H d = heat units found in dry coal.
M = percentage of moisture, in decimals.
A = percentage of ash, in pence.
P = contract price per ton, in pence.

"The fuel contract making use of this value is so worded that the company or middleman from whom the fuel is purchased agrees to deliver coal that has given certain specified results, which are included in the contract, at a certain price per ton. The net B.TH.U. for 1d. is afterwards worked out from these figures by the method described above, and is included in the contract as the 'contract guaranteed.' Should fuel showing a larger or smaller number of B.TH.U. per penny of cost be actually delivered, the price to be paid for the fuel rises or falls in a corresponding degree, the principle of the contract being that one penny is to purchase always the number of heat-units specified in the contract guarantee.

"In this way the price paid varies in an absolutely fair way with the quality, and both the seller and the buyer are protected from those pecuniary losses due to variations or irregularities in the fuel, over which they may have no control whatever, but which, under the existing system of purchase, occur frequently, and lead to much friction and unpleasantness.

"The delivered value of the fuel is obtained by taking a large number of samples during the delivery of the same, and by having each of these—or two very carefully prepared average samples—tested for moisture, ash, and calorific value. The delivered value (D v) of the fuel, for each test result, is then calculated by aid of the formula given below, and the average of the delivered values gives the price which must be paid for the fuel—

$$\text{D}\,v = \frac{\{\text{H}\,d - (\text{H}\,d \times \text{M})\} \times 2.240}{\text{C}\,g} - \frac{\text{A}}{4}.$$

Practical Working of the Method.—As pointed out in the introduction to this article, the Englishman in every walk of life is more open to conviction by means of practical results than by theoretical argument, and this article would therefore be incomplete and ineffective without the addition of one or two examples of the practical working of the system of purchase advocated. The writer is in a position to give the results obtained by two well-known firms who have been giving the system a trial in South Lancashire during the past 12 months.

The first is a large cotton spinning company, with a mill in the Manchester district. Their object in adopting the system was not "to steal a march in any way on the coal merchant, but only to check him as to the quality of coal

he was delivering compared with the samples upon which the contract was based."

Two carefully-prepared samples have been tested per month by the writer for this firm since the adoption of the system, and these samples have shown a striking uniformity in ash contents and calorific value, the variation from the calorific value of the sample, upon which the contract was based, being well within 5 per cent. for the whole of the period. In view of this result, it may be argued that the check was unnecessary—but this uniformity in the heat value of the coal actually delivered was no doubt largely due to the knowledge that the coal was being regularly sampled and tested at the consumer's works, and that any falling off in quality would be followed by a corresponding diminution in price. The users recognise this fact themselves, and have stated in a letter to the writer that "we are greatly in favour of the system of purchase upon calorific units. Since our contract of December, 1908, when we began the new system, he have had a much more uniform fuel supplied to us, which is all we aimed at."

Incidentally, this striking uniformity in calorific value proves that when the sampling and testing are carried out by qualified men, the results obtained are thoroughly reliable.

The experience of the second firm, who own several large corn mills in South Lancashire, has been rather different from the above, since marked variations have occurred in the quality of the fuel supplied, and in consequence there have been considerable reductions made in the price paid for the fuel. It is noteworthy that the largest increases in ash, and corresponding decline in calorific value, have occurred during the second half of the year, although the coal merchants declare they are supplying exactly the same fuel as in the earlier months. This falling off in the quality of the fuel contracted for lends support to the assertion that the operation of the Mines Eight Hours Act is also affecting the quality of the small coal raised and sold in the South Lancashire district.

It may be remarked in conclusion that neither of these firms had great difficulty in arranging for their 1909 contracts on the heat-unit basis, and in the first case the contract has already been renewed over 1910.

THE STOPPING OF LIFTS.

By F. O. HUNT.

The various forms of lift control have been a fruitful field for the inventor for many years past, and a considerable number of ingenious and intricate mechanisms have been evolved for the starting and bringing to rest, either automatically or otherwise, of hoisting gear. So long as the question was that of raising goods in a rapid and efficient manner, the problems of acceleration and retardation were not considered beyond the point required by safety and accuracy in starting and stopping, but as the comfort and convenience of electric passenger lifts became more and more recognised, it became of increasing importance to provide security against the sudden shocks and jars caused by careless and injudicious application of electromotive force to the motor, or of mechanical or electrical brakes to the mechanism. The superiority of one modern passenger lift over another depends, not so much on efficiency or safety in operation, inasmuch as these points have been so thoroughly investigated, as upon the comfort given to the passenger while occupying the lift. It can safely be said that the most comfortable lift, *i.e.*, the one giving smooth transition from high to slow speeds, and *vice versa*, is one which at the present day stands the most chance of favourable acceptance.

The consequence of this is that the activities of the lift attendant have been largely supplemented by automatic means of bringing the gear to rest, and of starting it up again, in a smooth manner, but they all suffer from a defect at one point, which belongs not to a highly specialised knowledge, but to the laws of elementary mechanics, that is, that the stored energy in the rapidly moving parts of the mechanism, which has to be absorbed in bringing it to a standstill at any floor, is dependent both on the velocity and upon the total mass of the moving bodies, in other words, we have to revert to the old familiar friend $k = \frac{1}{2} m v^2$.

The energy stored in the moving parts, whether cage, passengers, balance weight or mechanism, is therefore proportional to the square of the velocity at which that particular part happens to be moving. The square law is in one respect an advantage, as it has the effect of making the armature and brake pulley very important as stores of kinetic energy as compared with the remainder of the system. A considerable portion of the duty of the brake lies in the absorption of this kinetic energy, so that, given a constant speed of working, this has the effect of minimising the percentage variation in the total energy to be absorbed by the brake. On the other hand, it is necessary to keep this fly-wheel effect within somewhat close limits to avoid an unnecessary demand upon the motor and mains during the process of acceleration.

The law of proportionality to v^2 has, however, another effect which has not been generally recognised. The brake as usually constructed simply applies a certain definite pressure to the shoes through the whole period of stoppage, and consequently energy is absorbed at a rate proportionately to v. The brake thus has only a slight effect in reducing the speed when first applied; but as the velocity diminishes the relative effectiveness of the brake increases, and the negative acceleration goes on increasing until the instant of stoppage. This would result in a very nasty jar to the passenger if it were not minimised by the elasticity of the ropes. As it is, the stresses thrown upon the mechanism and the ropes at the final jerk are considerably greater than they need be.

It is thus evident that a brake that would absorb energy in proportion to the square of the velocity would be much more satisfactory, both by reason of accomplishing the stoppage in a shorter range and also by doing it in a manner which would be easier both for gears and passengers. Such a brake is applied to some extent when the motor-armature is made to generate current during the stopping process; but the method can be realised to the full extent in a brake such as that shown at fig. 1 (p. 16), which is extracted from a recent patent specification. In this arrangement, not only is the motor caused to act as a brake by generating current, but the current so generated passes round the coil (Z_3) and so determines to a large extent the pressure of the brake shoes, Z, upon the pulley. In order that the whole of the brake effect shall not be dependent upon the continuity of an electric circuit, it is advisable to retain a small amount of the usual spring pressure upon the brakes shoes at B.

Of course, so far as this part of the brake is concerned, the law of absorption of energy has the usual effect, but this is easily and cheaply compensated by attaching a copper ring to each side of the pulley. These rings, together with their fixing rivets, act in the same manner as the short-circuited rotor of a polyphase motor, and thus introduce into the law of the brake a component which varies approximately as the third or fourth power of the velocity. In this way it is possible by appropriate proportioning of parts to obtain a brake that will absorb power upon a law varying anywhere between v and v^3.

Another defect in the brake gear of modern lifts, and one which has, perhaps, been already appreciated more fully, is that which gives rise to the error of stopping point on lifts controlled by automatic push-button arrangements. In such cases, where a heavy load is being raised, or no load brought down, the cage is apt to stop before arriving accurately at the floor. And on the other hand, when no load is going up, or full load coming down, the cage is apt to travel beyond the floor where stoppage is intended. Until the above-mentioned patent was taken out, there does not appear to have been any serious attempt to get over this difficulty, makers having contented themselves with putting on a brake which was strong enough to reduce the whole length of "after travel" to the smallest amount consistent with safety to the gear, and undertaking only comparatively slow speeds where automatic stopping was required. These two precautions, of course, keep the stopping error within reasonable limits without tackling the root of the trouble. If higher speed lifts are needed something more is

required to meet the case. In the patent specification already referred to, the difficulty is attacked in a manner which appeals at once to the motor designer. Obviously, the amount of brake-torque necessary to stop the cage in a given fixed length of travel depends upon how much torque was necessary to keep the load in motion. Where much motive torque has been necessary, there little brake-torque need be applied, and *vice versa*. Thus the current in the motor armature when moving the load forms a perfect inverse measure of the amount of brake-torque necessary to stop the cage in the desired length of travel. This principle is applied in the case of mechanical brakes, by making

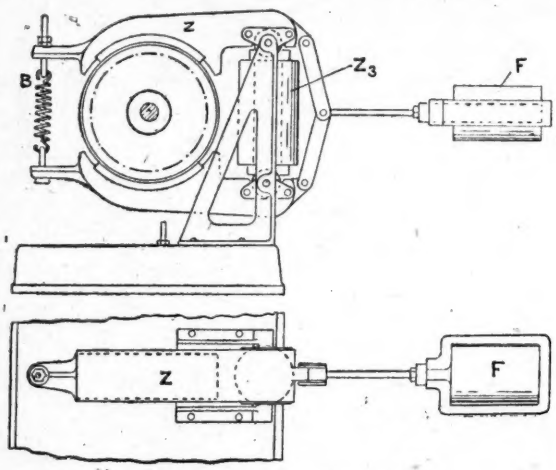


Fig. 1.—Brake for Lift Motor.

the current-measuring device vary the ratio of the levers by which the spring or weights acts upon the brake shoes, but it can be applied even more neatly in those cases where the motor armature is itself used to provide part of the stopping torque. It is then only necessary for the current measurer, during the run of the lift, to move a contact so as to adjust the amount of resistance which will be included in the armature circuit during the braking period when the motor is acting as a dynamo to assist the process of stoppage (fig. 2).

There is no doubt that passengers on lifts appreciate the starting and stopping comfort, and a little expenditure of money in this direction should prove to be of considerable value in increasing the popularity of the products of any manufacturer dealing in this particular type of transport apparatus.

COMMON COMMUTATOR TROUBLES.

By Cec. Toone.

During recent years an increasing number of complaints have come under the writer's notice of a type of commutator trouble which, at first sight, appears very mysterious. Certain bars round the commutator periphery are burnt badly again and again, and defy all attempts to keep them in good condition. Moreover, these bars occur at definite cyclic intervals round the commutator, and it is probably this fact which gives the trouble its uncanny nature. Where a few bars all close together are burnt, one examines the armature windings at the coils connected to these segments, the joints connecting the bars to the segments, and the insulation between the segments. As a rule, the cause of trouble is rapidly evident. Again, sparking under one set of brushes is generally traceable to incorrect setting of this group, either as regards circumferential pitch or as regards pressure, or again, is traceable to unequal gap length (caused by worn bearings) or bad or dirty brushes. Where the damage is caused equally by all the brushes, and yet selects certain definite bars in a constant numerical sequence round the commutator, the machine attendant frequently stands aghast and metaphorically "crosses" himself as being in the presence of some supernatural occurrence.

Yet this selective burning is uniquely characteristic of a certain class of fault. Though this fault is quickly identified, alternate bars being burnt, or possibly four bright bars being succeeded by two badly burnt, and so on, it is difficult to remedy, depending essentially as it does on bad design of the machine. The trouble is specially liable to occur on those small multipolar machines which one is apt to regard as the acme of modern design. The salient feature, which is the merit of these machines, is also their weakness in the present respect.

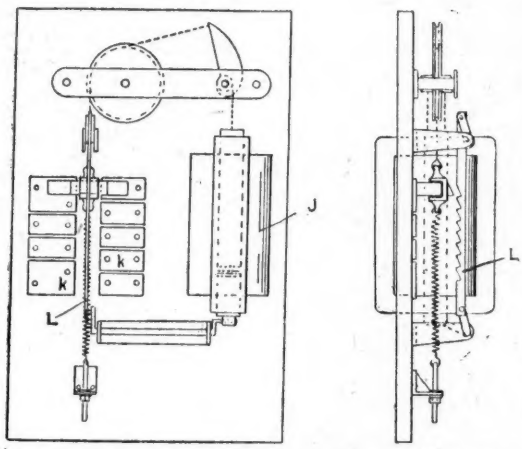


Fig. 2.—Automatic Controller of Braking Torque.

By improved ventilation methods the temperature limit of electric motors and generators is now generally far beyond the sparking limit. In order to wind a maximum number of ampere-turns on the armature, large slots are used to obtain a high space factor, and, the number of poles being high, the slots per pole occasionally fall as low as 7, though this is exceptional, and in such cases the number of commutator bars per slot may rise to 4, or even to 6. Such machines give remarkable results as far as concerns output per lb. of material, but are almost certain to give trouble by selective burning of the commutator bars.

The means by which selective burning is effected may be realised by reference to fig. 1. Suppose there to be only seven slots per pole, and each slot to be filled by 12 armature bars. The reactance voltage of six complete armature turns would be far too great to be dealt with by movement

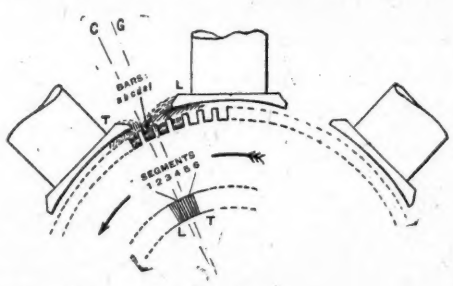


Fig. 1.

of the brushes alone (or by carbon brushes alone) in the majority of cases, for the reactance voltage rises with the square of the number of turns, other conditions being constant—since inductance varies as (flux × turns). Hence it is usual to connect only one turn across each segment; this would necessitate six commutator bars per armature slot in the present case, and, presuming a brush which will short four bars at once, it is clear that such a brush setting cannot be found as will suit all the segments shorted at a given moment. The trailing field T, fig. 1, is weakened by the armature distortion in the case of a generator, while the leading fringe L is correspondingly strengthened, so that while bar 1 is in the true axis of commutator C C, bar 4 is in a relatively strong field, due to L. This effect is

TABLE I.

No.	—	Amperes.	Volts.	KW.	R.P.M.	Poles.	Slots.	Segments.	Slots per pole.	Bars per slot.	Bars spanned by brushes.	Resctance volts.	Conductors per slot.	A.T. to overcome armature reaction.	Volts per segment.	Gap length, inches.	Apparent tooth density, lines per cm.²
1	Direct-coupled high-speed engine...	650	230	150	380	6	124	248	21	2	2·8	3·28	4	1,710	5·6	0·3125	19,900
2	Crankshaft type	1,250	240	300	90	12	264	792	22	3	4·2	3·20	6	3,170	3·6	0·375	23,100
3	Direct-coupled high-speed engine...	335	550	200	325	6	—	480	—	—	—	2·80	6	1,310	7·5	0·3125	—
4	Crankshaft type	1,400	600	840	230	12	250	750	21	3	—	—	6	—	—	0·625	15,500
5	Bad design	627	80	50	500	6	64*	192	11	3	6·0*	—	6	—	—	—	—
6	Bad design	627	80	50	500	6	96*	192	16	2	6·0*	—	4	—	—	—	—

*These are the bad features of these designs.

greater the sharper the fringe field. The closer together the pole tips become, the less gradual will be the gradation of the fringe field, the more sharply defined will be the axis of commutation, and hence the greater will be the difference in condition between coils 1 and 4 which, both being under commutation at the same moment, should both be in zero field, or in the case of metal brushes, in a certain commutating field. It is to be noted that in fig. 1, coil 4, instead of being in the reversing field from T, is actually subjected to a relatively strong positive field from L. With this setting of the brushes, therefore, bar *a* connected to 1 will be subjected to no sparking, while bar *b* will probably escape with little, if any, damage, but bar *c*, probably, and bar *d*, certainly, will be severely burnt, owing to the enormous current densities attained on these bars by the unsatisfactory commutating conditions prevailing. Bar *e* will be similarly burnt in its turn, while bar *f* will be nearly as much damaged. In such a machine, therefore, one would expect to find alternately three badly burnt bars, and three fairly clean bars. This alternation would persist right round the commutator, since the conditions would be identical with each slot, and its set of commutating bars, on coming into the plane C C. Were the brushes placed so as to bring 4 and *d* into the plane of sparkless commutation, the burning would be transferred to the leading edge L of the brush, the coil 1 now being shorted in too strong a reversing field. Owing to the weakening of the trailing fringe by armature reaction, the sparking would not be so serious as in the former case. If the brushes be set slightly forward of the position which brings the centre conductor of each slot into correct commutation, the best results are obtained. Though the bars at both edges of the brush will now probably be burnt, the damage will not be so severe as in either of the extreme settings.

TABLE II.—SHOWING VARIOUS BRUSH RULES AND CONSTANTS.

	Copper Brushes.	*Carbon Brushes.*
Contact resistance, ohms per sq. cm.	·00496 to ·0148	·148 to ·252
Contact resistance, ohms per sq. in.	·00077 to ·0023	·023 to ·039
Permissible current density, amps. per sq. cm.	23·3 to 39	3·7 to 7·75 (ordinary carbon)
Permissible current density, amps. per sq. in.	150 to 250	24 to 50 (ordinary carbon)
Permissible current density, amps. per sq. cm.	—	7·2 to 12·25 (softest carbon)
Permissible current density, amps. per sq. in.	—	46·5 to 80 (softest carbon)
Bearing pressure, kg. per sq. cm.	·07 to ·11	0·1 to ·25
Bearing pressure, lb. per sq. in.	1 to 1½	1½ to 3½
Coefficient of friction between copper and brush	0·2	0·3
Usual span of brushes (in commutator segments)	1½ to 1½	2 to 3

Without altering the armature winding, a remedy which is, of course, usually quite impracticable, further improvements can usually be effected by the following means :—

The brushes used should be as narrow as possible, so as to bring a minimum number of coils under simultaneous commutation. The brushes should be of as high resistance as possible, so as to reduce the short-circuit current flowing through those coils subjected to an incorrect commutating flux. This resistance is strictly only needed in the heel of the brush, and is sometimes provided there only, by the use of compound brushes. As a rule, Morganite brushes are used where carbon collectors are employed ; these brushes are of soft carbon having a low axial resistance but a high cross-resistance, and can be used with current densities up to 80 amperes per square inch, so facilitating the use of narrow brushes—ordinary carbon can only be run at 30-40 amperes per square inch (see Table II). Where metal brushes are employed, the compound type consisting of alternate layers of copper and high-resistance anti-friction metal should be used.

A further most important aid to commutation in such cases is the gradation of the fringe field. This is effected by boring out the pole face eccentrically (fig. 2), by the use of a slotted pole core (fig. 3), by chamfering,

FIG. 2.

FIG. 3.

V-ing, or skewing the pole tip (fig. 4), or by the use of laminated pole shoes arranged as in fig. 5. Without one of these devices, the fringe field of a machine with a slotted armature must inevitably be fairly sharp. Beyond these slight improvements little can be done to remedy selective burning of commutators ; and if these measures do not suffice, there is no alternative but to rewind the armature, or considerably reduce the loading of the machine. In cases which are very close to the border line of impossibility, some improvements can occasionally be effected by the use of very small section magnetic shunts across the pole tips, or by the use of copper rods placed axially through the pole shoes and connected at their ends, the object of this device being to grade the tip to tip flux and reduce its distortion by armature reaction. The flux density under the trailing horn should not be less than 20,000 lines per sq. in. for ring, or 13,000 lines per sq. in. for drum armatures.

The steps to be taken in design to avoid liability to such troubles as those mentioned above are : to employ a reasonably long air-gap (a short air-gap involves a flexible easily distorted field), not more than three coils per slot, and a brush span of not more than four segments in the case of carbon brushes, or two in the case of copper brushes. Such limitations, of course, necessitate the use of more material per kilowatt output, but the extra expenditure is well repaid by the improved working attained. Table I shows the proportions adopted in several recent machines of good design so far as concerns the present discussion. The rules above cited are conformed to in every case except the last two instances—purposely chosen as very bad designs, which gave trouble by selective burning of the commutator. The core teeth should be saturated as highly as possible, as the actual gap length then required is reduced to a minimum. The apparent flux density should be not less than 20,000—23,000 lines per square centimetre ; the armature reacting ampere-turns should be $\leq$ 10,000 per pole so long as the volts per commutator segment is greater than 5 but less than 10, or 20,000 per pole if the voltage be not greater than 5 volts per segment. These values may be compared with the data of Table I. A comprehensive series of oscillograms showing the current in the commutated coils of a machine for various conditions of load, various numbers of

coils per slot and various brush widths would greatly assist in the design of light machines for maximum output per lb. The use of too few slots per pole is also liable to cause sparking by the setting-up of too large potential difference between the commutator segments connected to the last bar of one slot and the first of the next. This cause is aggravated by a symmetry of coils as regards mutual induction, a condition very liable to occur in large slots.

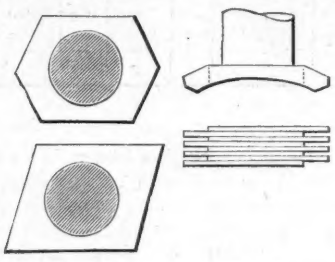


Fig. 4. Fig. 5.

It is well known that the flux from a pole tip is dragged forward in the case of a generator for a certain distance so as still to follow the more permeable path offered by a core tooth, and then is suddenly snapped back as the next tooth becomes available, cutting, as it does so, the conductors in the slot with a velocity considerably greater than the peripheral rotor velocity. Should this snapping back occur at the moment when one of the coils in the slot is under commutation, there would be a considerable current induced in the shorted coil, and sparking would ensue. A slight brush movement usually suffices to eliminate this trouble.

So far, only the most common cause of selective commutator burning has been dealt with, viz., that due to the considerable variation in field strength between points one core slot pitch apart, when the slots are too large. Other causes may be (1) failures in equaliser rings where used, (2) the use of too deep slots, (3) the use of "dummy" bars.

1. In some cases of the selective burning of the commutator bars it is found that the bars affected are those corresponding to the points of connection of the equaliser rings, and that the burning is due to excessive currents in the latter caused by an earth on one ring, wrong connection of the rings (*i.e.*, unequal pitch of tapping points) or unsymmetrical magnetic circuits due to field coil failure, worn bearing bushes, or similar reasons.

2. The use of too deep slots frequently causes trouble by the inductance of armature-turns depending on the position of the coil in the slot. These coils near the top of the slot have a considerably less inductance than those at the bottom, the latter being almost completely embedded in iron. Tunnel wound armatures give little trouble by such variations, while smooth-core armatures are, of course, inherently free from it. Consider an armature wound as in fig. 6, *i.e.*, on the usual step principle whereby a smooth finish is secured to the winding—the coils $a\,a' - b\,b'$ (and all similar pairs) are specially inductive, so that, using four

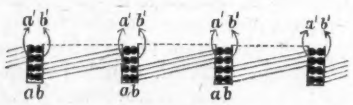


Fig. 6.

commutator bars per slot, every other bar has connected to it a specially inductive coil, since the reactance volts of commutation vary directly with inductance, sparking is specially liable to occur on every other bar, and will undoubtedly first spark selectively, even if finally resolving into general sparking on increased load. If the eight wires were wound as in fig. 6, every fourth bar would be very severely burnt.

3. It is occasionally necessary to employ "dummy" bars in some armature slots in order to obtain a number of effective conductors convenient for the type of winding proposed, in which case a want of symmetry is again created, and selective sparking is in consequence again likely to occur. The effects of mutual induction will be less in the slots containing the "dummy" than in the fully utilised slots.

In conclusion, it may be stated that, if selective burning of the commutator be noticed to any appreciable degree on a new machine, there is little hope of curing the defect except by more or less radical and costly structural alterations; but if the trouble develops on a machine which has run for some time satisfactorily, it can usually be traced to some breakdown or strain caused by a heavy overload or "short," to some change in the load conditions of the machine, or to variation in the adjustment of its brush gear. In such cases it is usually possible again to obtain satisfactory working by the substitution of carbon for copper brushes, by the careful gradation of the fringe field, or by very careful brush setting, or by a combination of these devices. It will be readily appreciated, however, that such a machine will always be ready to give further trouble on the slightest pretext, and its brushes must, therefore, be kept well trimmed, cleaned and of the correct pressure and setting, while the commutator must be polished as often as is necessary, and "high mica," "flats" and similar troubles rigorously corrected on their first appearance.

There can be no doubt that the above trouble has been greatly on the increase during the last few years, and is mainly traceable to the too-wide application of the principle of *concentration*; this principle must ever be subject to the essential requirements of engineering design—*reliability* and *efficiency*.

BUSINESS NOTES.

Calendars and Catalogues.—Messrs. Loxley & Co., Cabinet Chambers, Basinghall Street, Leeds.—A wall calendar with small monthly slips fastened below a colour-print copy of a view "Off the Coast of Devon" (by Warne-Browne). The firm's telephone number is now No. 75, they having moved into larger offices with stores, in the same building.

The Chemical Trade Journal has, as usual, issued a wall calendar for 1910 with large monthly tear-off sheets.

Messrs. Mather Bros., electric light and power engineers, 36, Farringdon Street, E.C.—Wall calendar with monthly sheets, each having also a calendar for the entire year. Most of the letterpress and illustrations are printed in blue, red being used for the days and dates.

From Messrs. Venner & Co., of 6, Old Queen Street, S.W., a set of monthly re-fill date cards for 1910 to take the place of those sent out last year with their very artistic calendar. Members of the trade who require these refills for their last year calendar can have same by applying to the firm.

Messrs. W. Coates & Sons, of Nottingham, have sent out to their friends a calendar consisting of a card resembling in appearance a ball of their twine, to which is attached a block of weekly date slips interleaved with touching entreaties regarding your twine orders.

Messrs. Falk, Stadelmann & Co., Ltd., 83-87, Farringdon Road, E.C.—Two new leaflets relating to "Efesca" tungsten lamps, one giving the "pros and cons" for the interest and instruction of the consumer, the other giving comparative costs of "Efescas" and carbon lamps.

The Armorduct Manufacturing Co., Ltd., Farringdon Avenue, E.C.—Twenty-page catalogue (green covers) of "Gral" metal lamps and metal lamp fixtures. Full size illustrations of various shapes of lamps are shown, also cuts of battery lamps, auto-transformers, lampholder husks and shell reflectors, shock absorbers and adaptors, opal and Holophane clusters, "Gral-arc" fittings for either interior or exterior lighting, ceiling fittings, lamp shades, and so forth. A number of the designs of fixtures are new. Prices are stated.

The D.P. Battery Co., Ltd., of Bakewell, Derbyshire, have issued a hanging wall calendar for the new year as usual. The pictorial feature appearing above the monthly calendar slips is a representation in colour of the Lumford Pack Horse Bridge with the company's works in the background.

From Messrs. Johnson & Phillips, Ltd., of Victoria Works, Charlton, we have received a vest pocket diary and engagement book similar to that issued by them a year or two ago. With an imitation crocodile binding and gilt edging it forms a very acceptable companion. For each day there is just sufficient space for the intended purpose.

Adnil Electric Co., Ltd., Adnil Building, Artillery Lane, London, E.C.—Leaflet showing and giving prices of direct-current motors of from ¼ to 5 h.p.

Messrs. J. H. Heathman & Co., Parson's Green, Fulham.—A batch of publicity literature relating to their ladders, ladder towers, fire appliances, &c.

The British Thomson-Houston Co., Ltd., Rugby.—Folding leaflet regarding the B.T.-H. three-phase oil switch panels and switches for use therewith.

The Westinghouse Co.'s Publishing Department, Westinghouse Building, Norfolk Street, W.C.—52-page fully illustrated brochure describing the Westinghouse silent rocker-joint chain drives (Morse patents). Descriptive matter is followed by weights and dimensions, and a good deal of general information of use in connection with the subject.

The Morgan-Reeve Co., Ltd., 12, Newgate Street, E.C.—Neat and clearly designed calendar for 1910 with monthly slips on which the figuring is brought out boldly. The company have also sent us a copy of a large telephone card that they are issuing to their friends. Members of the electrical trade can have copies on application.

Messrs. Wellman Seaver & Head, Ltd. (Electrical Department), 47, Victoria Street, S.W., have adopted for their souvenir a neat case containing two packs of pneumatic playing cards, one pack bearing on the back an illustration of the firm's self-aligning fuses, and the other their stamped corrugated resistance grids. The cards are of excellent quality, and we doubt not that they will serve for many a good game.

Messrs. Accumulator Industries, Ltd., 4, White Street, E.C.—We have received the "Electrical Engineers' Diary for 1910"—a large volume, with three days to the page of sectional paper, interleaved with blotting paper, and containing, in addition to numerous advertisements of electrical manufactures (including the "Leitner" accumulators), a variety of tables and data, formulæ, and other information of the "pocket-book" order, such as wiring rules, Home Office Regulations, &c. A special feature is a list of the streets covered by the mains of the London electric supply authorities, with the voltage and charges in each case. A list of provincial supply undertakings, with voltage and charges, is also given. Altogether a very practical and useful production.

The Forest City Electric Co., Collier Street, Greengate, Salford.—Large wall calendar with monthly sheets with clear figuring. Illustrations of the company's rail bonds, apparatus for electrically welding same, commutator segments, and drop forged terminals, appear above the calendar information.

Messrs. Crompton & Co., Ltd., Salisbury House, London Wall, E.C.—72-page publication (D 30) relating to their electrical mining equipments. In the preface it is pointed out that the firm has made a special feature of such machinery ever since its inauguration in 1876, and as indicating the extent of its business, it is mentioned that it has supplied to South Wales collieries over 20,000 h.p. of polyphase a.c. plant. The different sections of the pamphlet deal with the following: power stations, gas-driven generators, auxiliary machinery, switchboards, reversible boosters, main winding plants, haulage and haulage controllers, pumping, air compressors, ventilation, screening and surface work, surface auxiliary plant, repair shops, lighting and general mining work. The illustrations (half-tone) include views of the Arc Works at Chelmsford, of a colliery power station, and of plant appropriate to the matter in the several sections. A list of some collieries and mines to which Crompton machinery has been supplied occupies three pages at the end. We recommend this publication to the notice of all who are interested in the work of colliery electrification.

The Foster Arc Lamp and Engineering Co, Ltd., Worple Road, Wimbledon, S.W.—Illustrated descriptive price list of their "Q" type long-burning flame lamps, which are shown on another page of this issue.

The British Electrical Trade Supply and Bitumen Co., of Canal Bank, Trundley Road, Deptford, S.E., have prepared a capital diary for carrying in the breast pocket. In addition to quite sufficient daily space, there are note and cash account pages at the end. A few useful tables appear at the opening of the book showing wire gauges, sizes and weights, &c., of conductors and weights and measures. These is an insurance coupon in a roomy front pocket. The company will be pleased to forward a copy of their recently issued pamphlet on "What is refined Trinidad Bitumen?" to any reader who has not yet received one.

The M. & C. Manufacturing Co., Conduit Place, Paddington, W.—Illustrated price leaflet relating to the M. & C. auto-transformers; also specimen of a quotation inquiry card issued for the convenience of probable clients.

The Union Electric Co, Ltd., Park Street, Southwark, S.E.—List No. 1,015 (16 pages) containing illustrations and full particulars with prices of the "Union" country house electric lighting and power sets for working on petrol or paraffin, both for cell charging and for supplying energy direct to the circuit. The dynamo and engine specifications are given, and prices, &c., of sets and switchboards for 25, 50, 110 and 220-volt circuits are tabulated. Auxiliary apparatus and battery particulars and prices, diagram of connections, and shipping details, are given.

Messrs. A. Reyrolle & Co., Ltd., Hebburn-on-Tyne.—New pamphlet giving illustrated particulars together with code-words, prices, and dimensions of their L.T. tubular fuses. Copies can be obtained on application.

British Insulated and Helsby Cables, Ltd., Prescot.—New catalogue No. H. 48) of 60 pages, finely illustrated and well arranged, with glazed paper throughout, showing a variety of "Helsby" poles, fittings, and tools, for telegraph and telephone line construction, wooden poles, strutted poles, "A" and "H" poles, oak arms, tubular iron arms, pole roofs, iron poles, "Hamilton" poles, numerous fittings for such poles, cable suspenders, tool-kits, hand-carts, jointers' tents, and tools of all kinds for use in telegraph and telephone line work are shown, and prices are clearly indicated.

Premier Electric Control, Ltd., Red Lion Street, Clerkenwell, E.C.—Calendar for 1910, with an ingenious revolving injunction to buy Premier specialties, which pictorially wipes out all inferior apparatus.

A neat daily calendar, the central feature of which is a representation of a Pope's British-made metal-filament lamp, which will "reduce your lighting bill 75 per cent.," has been received from the makers of these lamps. The day, date, and month, appear through slots across the filament, and they are changed by turning small brass screws.

We have received from Messrs. Carl Hentschel, Ltd., of 182-184, Fleet Street, E.C., a 16-page brochure, entitled "What's Wrong with Trade?—A Word to the Wise," in which in quite entertaining style, and by the aid of amusing illustrations, he gently drives home the importance of having, as a leading aid to business progress, a first-class trade catalogue which shall be efficiently distributed.

Armorduct Manufacturing Co., Ltd., Farringdon Avenue, E.C.—We have received from "Armorduct," a neat perpetual desk calendar, and refills for the similar calendar received some years ago, the refills bearing particulars for the day, and a space for memoranda—not without a hint as to the virtues of the Armorduct wires and cables, conduits, lamps, &c. Refills and calendars can be obtained on application to the company; it is pointed out that by tearing off the leaves, as some do, instead of turning them over to the left-hand side of the board, users lose the advantage of the continuous record of the year's memoranda that results when the proper course is followed.

D.P. Batteries.—The Barrow-in-Furness Council has placed an order with the D.P. Battery Co., Ltd., for the renewal of one of their storage batteries and its maintenance for a term of 10 years. The same firm's tender has also been accepted for the renewal of the batteries of the Urban Electric Supply Co., Ltd., at Dartmouth and Newton Abbot, and their maintenance for 10 years

Holidays.—The works of Messrs. Kelvin & James White, Ltd., of Glasgow, are to reopen on Monday next, January 10th, after the New Year holidays.

Consular Notes.—Egypt.—The Belgian Legation in Egypt, in a recent report, states that the imports of electric, gas and petroleum motors into that country in 1908 amounted in value to £E90,536, as against £E108,814 in 1907, and £E117,054 in 1906. The value of the imports of electrical apparatus and telegraphic and telephonic apparatus in 1908 was £E119,311, as against £E191,950 in 1907 and £171,257 in 1906. The chief enterprises utilising electricity in Egypt are as follows:—

In Cairo.—The Société des Tramways du Caire, with headquarters at Brussels, with a central station comprising three turbines of 1,500 kw. The turbines are of the Brown-Boveri-Parsons type, and were erected by an Italian house. Each turbine works two dynamos of 750 kw. These dynamos and all the electrical material necessary to the turbines were installed by a Swiss house. There are eight multitubular boilers, installed by a London firm. The station also includes an electric generating group of 375 kw. The rolling stock includes 223 open motor-cars, 22 closed motor-cars, and 229 open trailers. All these cars were built in Belgium; the motors, of which there are two to each car, were supplied by Germany, America, Great Britain and Belgium.

The Cairo Electric Railways and Heliopolis Oasis Co., with headquarters at Brussels.—The company has one generating and one transformer station. A temporary works of 600 h.p. has also been constructed at Demerdach. It comprises two gas engines of 300 h.p. with gas generators. The accessory apparatus is worked by a petroleum motor and an electric motor. This temporary station supplies current to a permanent sub-station in the Oasis, where the current is distributed for electric tramways and lighting. The permanent works are situated at Choubrah on the Nile and the Cabal Sharkawieh, and produce three-phase current at 10,500 volts. The Choubrah works contain eight English boilers, feeding three turbo-alternators. The turbines are all of the Parsons type with surface condensers. Two have a power of 1,800 to 2,500 kw., and the third a power of 2,700 to 3,200 kw. The cables were supplied from Germany; the transformers, &c., from Belgium. The rolling stock includes 15 motor-cars and 15 trailers for the Ataba el Kadhra-Heliopolis line, and six motor-cars and four trailers for the Heliopolis-Palais de Keubbeh line. The cars and motors were supplied from Belgium. The length of line is 16 kilometres. The trolley wire was supplied from France, the posts from France and Germany and the small material for the line from France. The electric lighting installation has not as yet been developed very considerably, but it is likely to extend very quickly. The number of consumers at present is 23, and the number of lamps installed 1,291. The internal installation work is executed by the staff of the company. Cords and cables have been supplied from Germany and by a Milan house, and small materials and meters by a German house.

The Compagnie Centrale d'Eclairage par le Gaz, Lebon et Cie, with headquarters at Paris.—This company supplies electric light to the following towns:—Alexandria and Ramleh, Port Said, Cairo and Abbassieh, Boulacq, Choubrah, Ghezireh, Keubbeh, Matarieh, Zeitoun. The electric station at Alexandria supplies alternating current. The machine-room contains nine electric generators, and the steam engines of the five first groups have a total power of 1,400 h.p. The two supplementary groups consist of Laval turbines installed by a French house. The measuring apparatus, amperemeters, &c., were supplied from Germany, the meters from France, and the switchgear from the United Kingdom. The central administration of the company is at Paris, and orders for material for the local administrations are given there. Moreover, the company gives certain orders on the spot to encourage local trade in electrical goods. It has a large stock of electrical materials for interior installation work.

The Telephone Co. of Egypt.—This company exploits the telephone systems of Alexandria, Cairo, and Port Said, and various other towns of lesser importance, such as Mansourah, Tantah, Zagazig, &c. Each town has its local administration. At Alexandria the company has more than 2,500 subscribers, and the length of its underground cables there is 37 km. The company also works the lines belonging to the Government. It possesses a small electric generator for charging its accumulators, and a new one has just been ordered in Belgium. The Telephone Co. of Egypt, was formed by the Oriental Co., of London, and purchases are made through that company, except in cases of emergency, when materials are bought on the spot. The telephonic apparatus used came from Sweden, the distribution boards from U.S.A., the cables from Germany, and the batteries from the United Kingdom. The central battery system is being installed at Cairo, and the same system is proposed at Alexandria. The company installs the lines of the Egyptian and Soudanese Governments.

The Eastern Telegraph Co.—This company has a station at Alexandria, but all orders are given by the central office in London.

The Société Generale des Sucreries et Raffineries d'Egypte.—This is a French company using a considerable amount of electricity produced in its own works. The capacity of the machinery is 8,000 H.P. The machines were installed by French houses, and nearly all supplies are purchased in France, the annual expenditure on such supplies being from 6,000 to 9,000 fr.

Besides these large companies there are in Cairo several small electrical works which supply electric lighting at private establishments, *e.g.*, the large hotels, Shepheard's, Continental and Ghezireh Palace, the Khedivial Theatre, the Pyramides Restaurant, the railway administration, &c.

In Alexandria.—The Société des Tramways d'Alexandrie, which exploits the electric tramway system of the town. Its central station contains one Brown-Boveri-Parsons turbo-generator of 1,100 KW., supplied by a Swiss house, two American dynamos of 300 KW. each, and one American dynamo of 150 KW. The rolling stock includes 86 motor-cars and 73 trailers. The motor-cars are of various types supplied by English, Belgian, French and American houses. The trailers were supplied by Belgian, Italian and American houses. The length of line is 18·8 km. double line, and 5·5 km. single line, and the company is at present constructing a double line of 2 km. and a single line of 2·5 km. Further extensions are also proposed. The company is a Belgian concern with a capital of 8,000,000 fr., and having its headquarters at Brussels. The company makes its purchases through representatives of foreign houses in Alexandria.

The Alexandria and Ramleh Railway Co., Ltd.—This company exploits the electric tramway system of the suburbs of Alexandria. Its energy is produced by high-tension generators installed in the same works as those of the Société des Tramways d'Alexandrie. All the machines used were supplied by Swiss houses. The rolling stock consists of 40 motor-cars and 36 trailers, supplied by English and American houses. The system consists of 13 km. of double line. Purchases are usually made at Alexandria through the representatives of foreign houses. The capital of the company is 2,750,000 fr.

As at Cairo, there also exist at Alexandria, certain small electric stations for lighting private establishments, *e.g.*, the State Railway Co., the Casino of San Stefano, the Crown Brewery Co., the Bomonti Restaurant, the works of the Kafr Zayat Cotton Co., the works of the Salt and Soda Co.

In other Towns.—Cie. du Canal de Suez—Port Said; Cie. d'Eclairage par le Gaz (Lebon et Cie.)—Port Said; Cie. d'Eclairage Electrique de Tantah—Tantah; Cie. d'Eclairage de Mansourah—Mansourah; Cie. d'Eclairage Electrique de Suez—Suez; Khartoum Light Railway Co.—Khartoum; Khartoum Electric Lighting Co.—Khartoum. An electrical station has just been erected at Port Soudan to supply energy for use in the Port.

The following is a list of the principal merchants in Egypt who import electrical apparatus:—

At Cairo.—Cie. Egyptienne Thomson-Houston (lighting, heating, &c.); Société Generale d'Electricité et de Mecanique (lighting, heating, &c.); Thos. Cook & Son (lighting, heating, &c.); Cie. d'Eclairage par le Gaz (Lebon et Cie.) (lighting and heating); Siemens et Schuckert; Etablissements Eugen Nahman et Maroni; Lambert & Ralli; Orenstein & Koppel.

At Alexandria.—Cie. Egyptienne Thomson-Houston; Société Generale d'Electricité et de Mécanique; Thos. Cook & Son; Kirchmayer & Co. (apparatus, wires, cables, &c.); Cie. d'Eclairage par le Gaz (Lebon et Cie.); Hochapfel et Cie. (lighting apparatus); Egyptian Engineering Co. (lighting and power); Orenstein and Koppel; Lambert & Ralli.

Principal Commission Agents.—Hess et Cie.; Alb Seeger et Cie.; Baldovino et Angino; Arnaboldi; Lusena et Rosa; Sangrunetti et Teteschi; Stern Frères; Société pour le Commerce et l'Industrie; Maggiar et Gontier.

The following is a list of the apparatus chiefly used in Egypt with the country of origin:—Transformers, continuous and alternating-current dynamos, turbo-generators:—France, Great Britain, Italy, Switzerland, Germany and America.

The demand is mostly for medium and small power motors for small industries and for pumps, medium and small power dynamos for private installations for lighting and power. It is difficult to quote prices, which vary according to the kind and quality of materials used. The public, however, attach more importance to cheapness than to quality or finish in goods purchased, but this is not the case, of course, with the Government and the large companies.

Cables for power and lighting; aerial cables, bare or covered; subterranean cables, covered with various insulating materials of which the outside covering is usually tarred: France, Italy and Germany.

Wires and telephone cables: Germany.

Dry batteries and accumulators: Germany, France, Great Britain and Italy.

Lighting apparatus: Germany, France, Belgium, Austria. Cheapness in price is particularly considered.

Arc lamps are little in demand, but come from France and Germany, the price varying between 106 and 158 fr.

Incandescent lamps: Germany, France and Holland. Prices each—up to 20 C.P., ·40 fr. to ·45 fr.; 25 to 32 C.P., ·55 fr. to ·60 fr.; 50 C.P., 1·10 fr. to 1·25 fr.; 100 C.P., 3·50 fr. to 4·50 fr.; metal-filament lamps, 3·50 fr. to 5 fr.

Economical lamps find a considerable trade owing to the high price of electricity, but competition is very keen. The danger of breakages *en route* is very great, consequently good packing is a condition of success. If it were possible to decrease the number of breakages it would be possible to lower the price considerably, and a larger trade would ensue.

Ventilating fans: America.—These are in almost general use in Alexandria and Cairo—in the hotels, banks, warehouses, and in many private houses. The price of ventilators fixed to the ceiling varies from 200 to 400 fr., and of those for table use from 75 to 300 fr.

Telephone apparatus: if for public use, Sweden; if for private use, France and Germany.

Wires, covered with tissues: Italy and America. The demand for lighting purposes is for twin flexible cables. The demand for bell wire is for wire covered with paraffined cotton, a layer of rubber and sometimes a paper ribbon. Price 2·50 to 2·70 fr. per kg.

Bell apparatus: Cheapness is always demanded, and bells are sold retail at 2·50 to 4 fr.; the boxes are of metal and wood.

Insulating ribbon, white or black: Germany, Italy, Great Britain, France. Price 3·75 fr. per kg.

Cinematographs: Almost exclusively by a French house. These are extremely popular not only in Cairo and Alexandria but also in the provincial towns. The apparatus alone is sold at 800 fr. New films cost 1 fr. to 1·50 fr. per metre according to subject; used films cost 35 to 70 centimes.

As to conditions of payment, it may be said that incandescent lamps are sold cash against documents; wires and cables with credits of from three to five months. Apparatus, insulators, switches, are sold cash against documents, or with credit if the customer gives certain guarantees. Many small firms not having capital purchase on the spot on credit from the commission agents, who, themselves, buy from the manufacturers. For engines and dynamos payment is usually cash. In all cases of large orders the payment is divided up into two or three instalments, say, one-third on order, one-third on delivery, and the rest after a period more or less extended according to arrangement.

The small development of native industry limits the extent of trade in electrical apparatus and machines in Egypt. Nevertheless, there is very keen competition between Great Britain, Germany, Switzerland and France. Certain firms interest themselves in the business of their customers. To succeed in Egypt it is absolutely essential that firms should be represented on the spot; to send catalogues is useless. Agents should be chosen with care, since they will have to strive against representatives of powerful houses knowing their *clientèle* well. The qualities demanded for goods sent are cheapness, simplicity and solidity. When manufacturers have satisfied themselves as to the reliability of firms, it would be advisable to give credit.

PHŒNIX DYNAMO MANUFACTURING CO., LTD., Thornbury Works Bradford.—"Phœnix" Bulletin No. 3 (40 pages art paper, with a few admirably printed half-tone illustrations), in which are contained descriptions of their P.D.M. motors with auxiliary poles, an electrically-driven pneumatic hammer, motor-driving wheel lathe, C.B. type motor with reducing gear, &c. The bulk of the contents consists of tabular matter relating to outputs and prices of motors (constant and variable speeds, and totally enclosed), starting switches and shunt regulators, and dimensions of machines. There are some views of electrically-driven machines and pumps.

Bankruptcy Proceedings.—EDWARD WILLIAM BARTON WRIGHT, described as an electrotherapeutic specialist, Albemarle Street, Piccadilly, W.—An adjourned meeting of creditors was held on Monday, at the London Bankruptcy Court, under this failure. The debtor acted as managing director of the Bartitsu Light Cure Institute, Ltd., until January last, when the company went into compulsory liquidation. The business was sold in April, and the debtor has since acted as manager for the purchaser. Mr. E. Leadam Hough, Senior Official Receiver, reported that the meeting had stood adjourned to enable the debtor to submit a proposal for the consideration of his creditors. None, however, had been lodged, and the statement of affairs had not yet been filed. On behalf of the debtor it was stated that steps were being taken to set aside the receiving order on various grounds. The case was left in the hands of the Official Receiver, who intimated that in due course he would apply to the Court for an order of adjudication in bankruptcy.

ERNEST GOODMAN (E. Goodman & Co.), electrical engineer, Coventry.—January 17th is the last day for the receipt of proofs for intended dividend by Mr. C. J. Band, Official Receiver, 8, High Street, Coventry.

Private Meetings.—NURSEY & MARR, electrical engineers, 53, Victoria Street, London, S.W.—The creditors of the above were called together on January 3rd, when a statement of affairs was submitted, showing liabilities amounting to £1,413, of which £787 was due to trade creditors. Mr. G. Marr, the father of one of the debtors, was a cash creditor for £500, and interest

amounting to £25. The assets were estimated to realise £268, from which had to be deducted £29 for preference claims, leaving net assets of £239, and showing a deficiency of £1,174. In addition to the liabilities shown on the statement there were contingent claims of £79, none of which were expected to rank. It was stated that the debtors commenced trading in January, 1904, with a capital of £100. They traded fairly succes-fully up to a comparatively recent date. During the five years ended December, 1908, the debtors made profits totalling over £1,800, while up to December of last year their drawings had been about £2,000. The figures for the past year had not been extracted, but it was believed that a loss had been made on the trading during this period. Neither of the debtors possessed any private estate. The debtor Marr was married, but the household furniture was claimed by his wife. With regard to the claim of Mr. Marr, sen., it appeared that he lent £100 in August, 1907, and a further £400 in October of the same year. A receipt was given for the loan, together with an undertaking to repay the amount in January, 1912. The debtors had no offer to make, and it was stated that they left the matter entirely in the hands of the creditors. The accountant stated that the only question that the creditors had to decide was how the estate should be dealt with. If the matter was dealt with under a deed of assignment the cash creditor would postpone his claim, and the trade creditors would thus get the benefit of the whole of the assets. After some discussion a resolution was passed to the effect that the estate should be realised under a deed of assignment, with Mr. F. H. Sully as trustee. The following were also appointed to act as a committee:—Messrs. Cecil Hodges & Co., Messrs. William White & Co., and Messrs. Capel & Co.

Dissolutions and Liquidations.—BRITISH POWER TRACTION AND LIGHTING CO., LTD., Hull Road, York.—In applying for his release in *re* this matter, the Senior Official Receiver and Liquidator has issued a statement to the effect that "at the date of the winding-up order the whole of the assets of the company were in the possession of a receiver for the debenture-holders, whose claims amounted to £40,000. According to the director's statement of affairs, the assets were not sufficient to meet the debentures unless the works could be sold as a going concern. This proved to be impossible, and the total amount realised was not even sufficient to meet the expenses of carrying on the business by the Receiver; therefore, no return has been made to the debenture-holders. In these circumstances there is nothing for the unsecured creditors. The closing of the liquidation has been delayed in consequence of an inquiry directed by the Court in the debenture action as to the persons entitled to the proceeds of the sale of the assets."

LONDON ELECTROBUS CO., LTD.—A petition for the winding up, lodged by a creditor, Joseph Langley, of 51, Fairbank Street, St. Luke's, E.C., is to be heard in London on January 12th.

MESSRS. FOX & CO., electrical engineers, Bradford Road, Batley.—Messrs. Arthur Bagshawe, and W. J. R. Fox, jun., have dissolved partnership. Mr. Fox attends to debts.

HOW, PARTINGTON & CO., engineers, Alpha Works, Taffs Well, Glamorgan.—Mr. H. Boden How has retired from the firm, and all personal communications should be addressed to him at "Caragh," Velindra Road, Whitchurch, Cardiff. The business is being continued by Mr. Partington, as W. Partington & Co.

Trade Announcements.—THE ANDERSTON FOUNDRY CO., LTD, announce that in order to deal more expeditiously with the department which is handling their vertical, high-speed, multi-cylinder gas engines which have recently been put on the market, they have opened an office at Queen Anne's Chambers, Westminster, London, to which address all London inquiries and business relating to this department should be sent. Mr. Frank Adcock, who has been associated with the development of this engine at the firm's works since its inception, is in charge of this office.

THE FRANCO-BRITISH ELECTRICAL CO, LTD., have now moved to larger and more convenient showrooms and offices at 50, Oxford Street, W. Their telephone number, "374 City," remains unaltered.

MR. VERDON O. CUTTS, who has been for nearly seven years with Mr. T. Scott Anderson, consulting and contracting engineer of Sheffield, has now started on his own account at 87, Fargate, Sheffield, where he will deal in manufactures for electric power, lighting, and lifting plant and accessories, especially for steel works, mill, and colliery requirements. Mr. Cutts desires to receive manufacturers' catalogues and price lists.

MESSRS. WALLACH BROS., LTD., of Royal London House, Finsbury Square, E.C, have been appointed sole agents for the Turner Oil Filter Co., and all inquiries for Turner filters should be addressed to them.

As from January 1st the business of SELIG, SONNENTHAL & CO. has been, for family reasons, formed into a private limited liability company under the style of the Selson Engineering Co., Ltd. All the assets and liabilities of the old firm and of the Selson Machine Tool Works, Coventry, have been taken over by the new company. The business will be carried on exactly as before, and under the same management.

THE UNDERFEED STOKER CO., LTD., have appointed Messrs. D. T. Keymer & Co., 5, Mangoe Lane, Calcutta, for the sale in India of their underfeed stokers, mechanical draught, and air heater equipments. Mr. B. W. Bagshawe (up till recently the Underfeed Stoker Co.'s representative in Scotland, and a power expert, will undertake the management on behalf of Messrs. Keymer & Co.

MR. JOSEPH DAWSON has taken over the business of Williams and Dawson, electrical engineers, 146, St. Paul's Road, and 23, Avenham Street, Preston, and will carry it on under the style of Dawson & Co.

MR. G. BRAULIK announces that owing to the large increase in business in his engineering department during last year, he has decided to separate same from his ordinary supply business. For that reason he has commenced a new department which will be carried on under the name and style of the Braulik Engineering Co., 8, Lambeth Hill, London, E.C. Mr. E. Eugene Brown, M.I.E.E., has joined the firm and will supervise all technical engineering specialities in which they deal, and also partly manufacture in this country. The specialities in which this department will mainly deal, and for which the firm have sole agencies, are the following:—Dynamos, alternators, and motors, turbine plants, economisers, gas, oil and petrol engines, suction gas plants, pumps, measuring and recording instruments, motor controllers, regulators, and starters, switches and switchboards, insulating varnishes and materials, and vacuum drying plant, also wood-working, brick-making, ice-making and moulding, machinery, cranes and lifts, motor-cars and accessories, telephone and telegraph apparatus, arc lamps, &c.

THE BRITISH HIGH-POWER GAS ENGINE CO., LTD., has been registered, with offices at 3, London Wall Buildings, E.C., to devote itself to high-power gas engine installations. It has acquired a gas engine of the double-acting four-cycle type, for the manufacture of which Messrs. Fraser & Chalmers, Ltd., have been secured as licenses. The directors of the new company are:—Messrs. Walter McDermott, David Neustadter, and Alexander Smart.

MR. JOSHUA WHITFIELD has commenced business as an electrical engineer at Shipley (Yorks.)

MR. H. E. MCKELL, having concluded his arrangements with Callender's Cable and Construction Co., Ltd., is advertising his readiness to take up a new appointment.

MR. ALBERT BRAUCKMANN, manufacturers' agent, has removed to larger premises at 19, Chapel Street, Milton Street, E.C.

Bradford Electricity Department.—The offices of the Bradford Corporation Electricity Department have been removed from the temporary premises occupied for some years past, at Whitaker Buildings, Victoria Square, and are now in the Extension to the Town Hall, which has recently been completed. The new premises are much more adapted to the needs of the staff, which has, of course, grown considerably. A small showroom has been fitted up adjacent to the inquiry office, so that callers cannot fail to see the exhibits of fittings, motors, heating and cooking apparatus, for use on D.C and A.C. circuits. The Department will at all times be glad to receive particulars regarding new apparatus for the utilisation of electrical energy. The large general office is to be illuminated by the "Moore" yellow vacuum tube light. The apparatus is now being fixed. A further installation of the "Moore" white light for colour-matching is to be fixed up in another room, should the installation of the yellow light prove satisfactory.

Russian Exhibition.—The Council of the Association of Petersburg Manufacturers does not favour the projected Russian Exhibition in London in 1911. It is stated that owing to the present unfavourable economic state of Russian industry, and the consequent difficulty of making a worthy exhibit in a country so highly developed industrially as is Great Britain, the project would not find a satisfactory response in Russia. This seems to us to make it the more necessary for British manufacturers to throw their energies into the proposed scheme for an Exhibition of British Manufactures to be held in Russia, to which we have made allusion on several occasions.

Manchester Exhibitions.—We have received from their respective promoters, particulars of the two exhibitions that are being arranged for Manchester. The *Engineering Review*, as promoters of the Engineering and Machinery Exhibition of October 14th to November 5th, 1910, have issued particulars of the power, lighting, stand erecting, and other arrangements, with net costs of same, for the convenience of exhibitors. The advance prospectus of the Manchester Industrial Exhibition (May 12th to June 25th, 1910) has also been issued by its organisers, the International Trade Exhibitions, Ltd. Among the classifications are sections devoted to ventilating and heating, lighting, and to machinery as applied to a variety of industries.

Book Notices.—*One and All Gardening*, 1910. (Advance copy.) Edited by E. O. Greening. London: Agricultural and Horticultural Association. 2d.—One of the chief articles in this issue is entitled "Labour and Delight," and it describes developments of garden houses in connection with profit-sharing co-partnership; but there is a great deal of other matter of direct interest to the gardener who has his own little parcel of land to improve.

"*Proceedings* of the American Society of Civil Engineers." Vol. XXXV, No. 10. December, 1909. New York: The Society.

Fires.—THE EDISON & SWAN UNITED ELECTRIC LIGHT CO., LTD., desire to inform their customers that the small fire which occurred in their Queen Street premises on Monday last was confined entirely to the test room, and will not in any way interfere with the conduct of their business.

On the night of December 28th a fire occurred on the premises of the IMPERIAL LIGHTING CO., of 157, Blackfriars Road, S.E.

LIGHTING and POWER NOTES.

Ardsley.—The U.D.C. has consented to energy being supplied by the Yorkshire Electric Power Co. to the works of the Howley Park Quarry Co., subject to the interests of the Council being safeguarded, and the payment to the Council of a royalty of 2½ per cent. on the amount paid by the Quarry Co.

Barton-upon-Irwell.—The B. of T. has revoked the 1906 E.L. order as to so much of the area as is described in Part II of the First Schedule, *i.e.*, the parishes of Barton Moss, Davyhulme, and Flixton.

Brazil.—Within the next nine months it is intended to light the centre of the town of Rio de Janerio with electricity, and also to extend the lighting to the suburbs of Botafogo, Gavea, and Larangeiras, &c.

Canada.—The American *Electrical World* states that an election was to be held in Montreal on December 21st to vote upon a by-law passed by the Council involving an expenditure of $2,000,000 for a municipal lighting plant. The Legislature has already granted the city the right to borrow the money, provided that the plan is approved by a vote of the real estate owners.

The *Canada Gazette* of December 11th contains a notice to the effect that the Minister of the Interior recommends the granting of an application from the Burrard Power Co., for the right to erect a dam at the lower end of Lilloet Lake in the railway belt in British Columbia, and to divert the water to a power house to be erected about four miles down the Lilloet River from the lower end of the lake, for the purpose of generating electric power.

Chile.—According to a German Consular report, Eugenio de Toro has undertaken to supply Limache, Quillota, Pena Blanca, Villa Alemana and Quilpué with electric light from his generating station at Tabolango (Province of Concepcion).—*Board of Trade Journal.*

Clyde Valley.—The Clyde Valley Electrical Power Co. has contracts with consumers for 30,346 H.P., and has in view an addition of 6,500 H.P. to its plant capacity.

The large shipbuilding yard at Renfrew, on the Clyde, of Lobnitz and Co. will shortly have all the plant driven electrically by three-phase alternating current supplied by the Clyde Valley Co.

Derby.—The T.C. has decided to supply energy to the premises of Mr. Wm. Fletcher, Nottingham Road, by means of an overhead cable at a cost of £250.

Dublin.—The City Council has had under consideration the report of the Electric Lighting Committee showing that the use of the metal-filament lamp has resulted in a saving of £15,000 per annum to consumers, and recommending an increase of 10 per cent. in the lighting rates. After a long discussion it was agreed by 47 votes to 8 to try an increased rate for one year.

Eastbourne.—The T.C. is to apply to the Local Government Board for sanction to borrow £1,835 for condensing plant at the electricity works.

Grangemouth.—The T.C. has been negotiating with the Scottish Central Electric Light Co. with a view to the latter taking over the order at present in the name of the Corporation and introducing electricity into the town. The matter has been remitted to a Committee, and, subject to certain alteration, the Provost was authorised to sign the agreement with the company.

Grimsby.—The Corporation has issued a handy pamphlet for use as an electricity consumers' guide, dealing under numbered paragraphs, with the various matters which are most likely to appeal to would-be consumers, and including wiring, lamps, cost of installation, systems of charging, and annual cost of electric light. This booklet will be appreciated by those who are seriously considering the adoption of electric light, as it contains a good deal of information and certain useful hints which are not usually found in this class of literature.

India.—MADRAS ELECTRIC SUPPLY CORPORATION.—An Indian correspondent writes:—Work is now in full swing, and connections to the mains are being made daily. Prosperity is already assured, and the undertaking is bound to be an unqualified success to the undertakers. Many of the local mill owners are negotiating for a supply of cheap power, and arrangements have been concluded with the Tramways Co. to supply its requirements in bulk.

Leyland.—The B. of T. has revoked the 1902 E.L. order.

Liverpool.—The consulting electrical engineer to the Corporation (Mr. A. B. Holmes) has submitted a report on the charges for electrical energy in the city, to the Tramways and Electric Power and Lighting Committee of the City Council, and the latter has adopted the recommendations contained in the report. He points out that the proposed new alternative method of charging renders a second meter and wiring system unnecessary, and affords the greatest possible inducement for the development of the domestic uses of electricity. He recommends the trial for a period of 12 months of the following method of charging for private houses of not less than £20 rateable value: A fixed quarterly payment of 3 per cent. on the rateable value of the house, and a charge of 1d. on each unit as measured by the meter. Already to facilitate the use of electric light in small houses, prepayment (1s. in the slot) meters are supplied when desired. The charge for energy so supplied is 4d. per unit, which includes meter rent and maintenance.

London.—WOOLWICH.—The B.C. has decided by 15 votes to 14 to open a showroom, information bureau and offices for the electricity department in Powis Street. The lease of the premises is to be acquired, and not more than £1,500 expended on alterations and repairs.

HAMMERSMITH.—In October last the Council approved the general conditions for the purchase from the Kensington and Notting Hill Electric Lighting Companies, and the supply to the Exhibition premises, of three-phase current for a period of four years from January 1st, 1910. In the agreements, however, with the respective companies, the period is to be for one year, as it has been found impracticable to fix a price for four years.

Mirfield.—At a meeting of the U.D.C. on December 29th the clerk reported that the borrowing powers for E.L. extensions had now become exhausted.

Morecambe.—The T.C. has decided, by 14 votes to 7, not to supply energy to the works of T. W. Ward, Ltd. It was proposed to give a supply at 1½d. per unit for not less than 1,000 units per week on a five years' agreement, provided that the firm's works were continued during that period. The estimated capital expenditure to give a supply was £2,500.

Oldham.—At a recent meeting of the Electricity Committee the question of abandoning the old Rhodes Bank station was mentioned. Mr. Newington reported that if they did not remove the mains to the new station as had been proposed, they would have to carry out some alterations to satisfy the B. of T. He thought it would be better to shut down the Rhodes Bank station, as there was space for an additional 3,000 KW. of plant at Greenhill.

Pontypridd.—The Electricity Committee of the U.D.C. has decided to apply for sanction to borrow £5,362 for the provision of an additional unit in connection with the department's dust destructor. Plans and specifications are being prepared by the engineer, Mr. J. E. Teasdel.

Rotherham.—The R.D.C. has been informed that the Sheffield Corporation E.L. Order affecting the parish of Tinsley, in the area of the R.D.C., will not be proceeded with.

Mr. Edward Cross, the electrical engineer, reports that the Wincobank generating station has been running experimentally for a few weeks, and the machinery is giving every satisfaction. The estimated number of units output will be approximately 360,000. The tramway receipts for the month of December was £2,538, an increase of £109 over the corresponding period of 1908. The manager attributes this to the return to College Square as a central terminus.

Glasgow.—Two electric transporters are in course of construction at the Rothesay Dock, Glasgow. These are for unloading ore into wagons, or on to the quay, or into bins. Two electric coal hoists are also being erected on the north quay. The south quay has now eight four-ton electric cranes for the discharge of iron ore. All the hoists, cranes, transporters, capstans, and turntables, are worked by electricity.

Smethwick.—The T.C. has appointed a Special Committee to consider the application to the B. of T. for an order authorising the transfer of the E.L. order from the Birmingham and Midland Tramways Co. to another company.

Staines.—Some time ago an agreement was arrived at between the Egham Electric Lighting Syndicate and the Staines U.D.C., whereby the former is to supply electricity for lighting between dusk and dawn. The time for lodging objections to the order obtained by the syndicate expired on December 31st. The Staines Chamber of Commerce lodged one objection, and it is understood that there are others.

Tasmania.—In a report to the Tasmanian Mines Department, Mr. Ryan, of the Pioneer Mine, gives some particulars of the electrical plant used in connection with the sluicing plants. A large dam having been constructed for the latter, the water is intercepted 1½ miles lower down and utilised in three Voith turbines direct-coupled to 375-KW. A.E.G. 6,500-volt three-phase alternators, the available head being 440 ft. Energy is transmitted four miles to the workings, where two 400-B.H.P. motors, driving 16-in. sand pumps, carried on barges, are supplied. The motors' speed is controlled by liquid controllers, as well as by varying the driving pulleys. Carriage-type switchgear and automatic voltage regulators are provided, and the installation is stated to be on the most modern lines.

Tewkesbury.—The T.C. has given permission for the E.L. Co. to use an overhead cable from the generating station to the Abbey Mills.

Trowbridge.—The U.D.C. has decided not to let the E.L. question drop, although the B. of T. has revoked the order. At the last meeting of the Council, the chairman said it was possible that in the spring they would hear of something being done in the matter. Cable is already laid in the town.

Uxbridge.—The liquidator of the Uxbridge and District Electric Supply Co. has informed the U.D.C. that certain proposals are being made by the Metropolitan Electric Supply Co., which holds most of the debentures, with a view to the property being released in favour of the debenture-holders. He suggested that the

Council had now an opportunity of taking over the concern and obtaining a new provisional order; the Council has, however, taken no action in the matter.

U.S.A.—According to a recent report to the State Government, the textile mills of South Carolina now employ 45,478 hydro-electric H.P., 16,375 electric H.P. generated by steam, 26,235 water H.P. and 76,734 steam H.P.—*Electrical World.*

TRAMWAY and RAILWAY NOTES.

Aberdeen.—The burgh surveyor, tramway manager and electrical engineer are to report to the Corporation as to the relative cost to their respective departments of relaying the tramway track of Great Northern Road from Kittybrewster to the Woodside terminus.

Argentina.—It is announced that the concession for the construction and working of an underground electric railway network at Buenos Ayres has now been definitely granted by the city authorities to the Anglo-Argentine Tramways Co. and the Compagnie Générale de Tramways de Buenos Ayres. The underground railway, which will consist of three lines, will be worked in conjunction with the tramways at present in operation. The agreement fixes the duration of the concession at 80 years, and also brings to a uniform term of 80 years all the concessions worked by the Anglo-Argentine Co., some of which only had a currency of 50 years. On its part the company has undertaken to pay 6 per cent. of the gross receipts to the city, together with an additional 12 per cent. on a portion of the receipts exceeding a fixed sum per mile and per annum. The underground lines will also be subject to the payment of 6 per cent. of the gross receipts, but will be exempt from the 12 per cent. additional tax. At the same time when joint tickets for the tramways and railway are issued this fact will have to be considered when calculating the amount of the additional tax to be paid by the tramways. The three underground sections are:—(1) Plaza de Mayo-Plaza Once; (2) Plaza Constitution-Estacion Retiro; and (3) Plaza de Mayo-Plaza Italia, the total length being about 9·3 miles. The first section is to be completed by June, 1913, the second by December, 1914, and the third by December, 1917. It is stated that the whole of the undertaking and rolling stock will pass into the possession of the city free of charge on the expiration of the concessions.

Bournemouth.—The B.C. has received a report which shows that claims totalling £26,450 received in connection with the tramway accident of May 1st, 1908, were settled for £11,324; the total amount expended was £11,983, less £3,475 insurance money, or £8,508.

Brazil.—The *Diario Official* of November 27th contains a decree approving the plans submitted by the Rio de Janeiro Tramway, Light and Power Co. for the electrification of the Corcovado Railway.

Canada.—According to the American *Electrical World*, there is a probability of the Canadian Pacific Railway Co. constructing a tunnel under Montreal for the purpose of connecting its two stations, the trains to be operated by means of electricity. Plans for extensions to both stations are under way. While the distance between Windsor Street and the Place Viger is only 1½ miles, the trains having to make this journey must traverse no fewer than 18 miles of track, which long detour means a large added expense in the haulage of freight. It is thought that the tunnel would, in the long run, prove a great economy, and at any rate, it is admitted that it forms the most feasible solution of the serious problem of transportation from one station to another.

Applications will be made to the Parliament of Canada in its present session for an Act incorporating the Ottawa, Rideau Valley and Brockville Railway Co., with power to construct a railway worked by electricity or other motive power, from Ottawa to Brockville, and a line from Ottawa to High Falls, to develop water-power and to generate electrical energy; and for an Act incorporating a company, to be called the Toronto Central Terminal Co., with power to construct passenger and freight stations, warehouses and other terminal facilities at Toronto, and to construct electric lighting plants.—*Board of Trade Journal.*

Chile.—It is stated that Eulogio C. Lorca and José Constantino, of Santiago, have obtained a concession for the use of water-power from the Colina River for the generation of electricity with which to work the Valparaiso-Llaillai-Santiago and Llaillai-Los Andes railway.—*Board of Trade Journal.*

Continental Notes.—SWEDEN.—A report has been published in a Swedish engineering journal by Chief-Engineer Quistgaard, on the subject of constructing a tunnel railway under the Sound, between Copenhagen and Malmö, so as to form a connection with the Swedish-Norwegian railway system on the one hand, and the Danish network on the other. The author, who has occupied himself with the question for many years past, was at first not regarded as being serious in some quarters, but it is now said to be the general opinion that the scheme could be carried out, and that it will sooner or later engage the attention of authoritative circles. Two projects were first considered by the engineer, one being for a tunnel between Helsingör and Helsingborg, and the other for a tunnel between Copenhagen and Malmö. The former was regarded as impracticable, owing to the extremely unfavourable depths at the northern part known as the throat of the Baltic, but the position is quite different in the case of the latter. The labours of the author in respect of the Copenhagen-Malmö scheme have so far proceeded that copies of a detailed plan have now been distributed among the members of the Swedish Parliament. It is proposed under this project to commence the projected electric railway at the new central railway station in Copenhagen, and proceed in a south-westerly direction to the Frederiksholm brickworks, whence the line would be continued by means of an embankment and a bridge to the island of Amager, at the southern point of which would be the entrance into the tunnel portal on the Danish side. The first portion of the tunnel is to connect Copenhagen with the isle of Saltholm in the Sound, and the railway would be carried over the island in the open for a length of about 1·86 miles, where it would again become a tunnel line on the east coast. This second tunnel, between Saltholm and Sweden, would end about one-third of a mile from the Swedish coast at Schonen, whence the railway would be continued to Malmö. It is considered that the construction of the tunnels, which would be of the tube type, would not present any special difficulties, as the average depth of the sea is only about 35 ft. The total length of the railway would be 22·3 miles, and if a speed of 37 miles an hour is assumed, the electric railway would shorten by 1½ hours the time occupied in making the journey by rail and ferry at present.

SWITZERLAND.—It is proposed to convert the steam tramway between Bonn, Godesberg, and Mehlen into an electric line.

RUSSIA.—A proposal has been made to convert the horse tramways in the town of Baku, on the Caspian Sea, to electric traction.

Grimsby.—A light railway service between the borough boundary and the Immingham Dock has been put into operation with steam cars. The line will, however, be coupled up to an electrical line into the town, and may be worked electrically throughout.

India.—MADRAS TRAMWAYS.—Probably the very oldest system of electric tramway in India is that in Madras. Originally it was an underground conduit system, designed and carried out by the E.C.C., but the first monsoon weather proved that in practice it had many drawbacks. The tramway was laid down in 1895, and soon converted to an overhead trolley-wire system. For 13 years the scheme has operated with varying degrees of success, and against many disadvantages. This year, however, the Government, having regard to complaints as to the condition of the rolling stock and permanent way, has issued an order empowering the Corporation, through its engineer, periodically to inspect the system, and to call on the company to make good any defects, the Government being the arbitrator in case of disputes.

Leyton.—Alterations to the switchboard and meters are necessary on account of the increased load which will result from the substitution of the larger L.C.C. cars for Leyton cars. The cost will be about £30. The result of the experimental through running with Walthamstow from Chingford Mount to Stratford Broadway has proved satisfactory, and an agreement is now to be entered upon for a minimum of one year.

London.—HAMMERSMITH.—The Arbitrator appointed by the B. of T. to inquire into the differences between the Council and the London United Tramways, Ltd., with regard to the condition of the tracks, has written to the Council with reference to its application to the B. of T. for the withdrawal of the order for arbitration, which he says he assumes will be allowed, and he takes this as a conclusion of the matter so far as he is concerned, and a release from any engagement therein.

Musselburgh.—The extension of the Electric Tramway Co.'s system, a ½-mile stretch of single track, with passing loops, from East Lorimer Place, Cockenzie, to Port Seton, has been opened for traffic. The cars have now a run from the Edinburgh car terminus at Joppa, eastward, of 7 miles.

Quarry Bank.—The B. of T. has granted an extension of the Quarry Bank, Rowley Regis, and Brierley Hill Light Railway Order until February 23rd next. Unless some definite arrangement is made before that date for the construction of the tramway, no further extension will be granted.

Tyne Tube Scheme.—The North and South Shields Electric Railway Co. has deposited a Bill for a revival of the powers for the construction of the railway under the river Tyne between North and South Shields, which were originally granted in 1902 and revived in 1906. It is now proposed that the land necessary may be purchased "during, but not after, a period of two years from the passing of this Act," and that the railway shall be completed by July 31st, 1913.

U.S.A.—It is reported from Chicago that Mr. J. P. Morgan has sold his interests in the City Railway Co. and other Chicago lines to a syndicate for $70,000,000. This is a step towards the unification of the surface and elevated railways of the city.

TELEGRAPH and TELEPHONE NOTES.

Cables Interrupted and Repaired.—Obok-Djibouti, repaired December 28th, 1909; La Reunion-Mauritius, repaired December 29th, 1909; Saigon-Tonkin, repaired January 1st, 1910: Bathurst-Bissao, repaired January 3rd, 1910; Lagos-Kotonou, interrupted January 3rd, 1910. Owing to the breakdown of the Stornoway cable, all telegrams from and to Lewis, Harris, Uist and Barra have had to be transmitted *vid* Lochboisdale and Tobermory by the wireless stations since Christmas Day.

United States.—A Special Committee appointed by the New York State Legislature to investigate telegraph and telephone conditions in the State, and to determine whether the services should be placed under the supervision of the Public Service Commission, has been holding meetings in New York since December 1st. The question of the purchase by a rival company of the large parcel of Western Union stock came up for consideration, and Mr. Vail, the president of the American Telephone and Telegraph Co, explained that the object in view was the building up of a national system of combined telephony and telegraphy. Mr. Vail also stated his opinion that a telephone monopoly would give the best service in any community.

Wireless Telegraphy.—Lloyd's Register for 1908-9 shows that, during that year, there were recorded in their registers 404 vessels fitted with wireless telegraphy and 382 with submarine signalling apparatus.

A wireless station has been opened in Algiers.

The Russian Government has made contracts for "eight-kilowatt" wireless stations at Petropavlovski in Kamchatka and Nikolaievsk, on the Sea of Okhotsk, on the Telefunken system.

The Marconi Co. has secured a licence at Johannesburg, and proposes to compete with the cable companies by introducing a charge of 1s. per word, the present cable rate being 2s. 6d. per word. The concession lasts for 20 years, and after its expiry the station becomes Government property.

A Reuter dispatch from Melbourne states that the conference of representatives of the Admiralty, the Commonwealth, New Zealand and Fiji, which recently met there to consider the question of wireless telegraphy in the Pacific, recommends the establishment of high-power stations at Sydney, Doubtless Bay (New Zealand), Suva and Ocean Island, and medium-power stations in the New Hebrides and Solomon Islands. All the stations are to be controlled by the Government.

CONTRACTS OPEN and CLOSED.

OPEN.

Acton.—January 18th. Electrical supplies for the U.D.C. for one year. See "Official Notices" to-day.

Australia.—MELBOURNE.—February 2nd. Electrically-driven pump for the City Council. See "Official Notices" December 10th.

MELBOURNE.—Seven sections of branching multiple magneto switchboard for the P.M.G. See "Official Notices" to-day.

Wireless telegraph installation (*a*) in or near Sydney, N.S.W., and (*b*) in or near Fremantle, Western Australia. See "Official Notices" to-day.

SYDNEY.—Two junction-line sections of common-battery switchboard for the P.M.G. See "Official Notices" December 24th.

SOUTH AUSTRALIA.—Telegraph and telephone material for the P.M.G. See "Official Notices" December 24th.

Belfast.—January 10th. One 1,500-KW. continuous current turbo-generator and condensing plant for the Corporation. See "Official Notices" December 10th.

January 31st. Two water-tube boilers, superheaters, mechanical stokers, economisers, pipework, &c., for the Tramways and Electricity Department. See "Official Notices" to-day.

Brighton.—January 10th. One 3,000-KW. three-phase turbo-alternator, with condensing plant, &c.; one 1,300-H.P. 8,000-volt three-phase induction motor; one 300-KW. induction motor-driven balancing set; high-tension switchgear, &c., for the Council's North Road sub-station. See "Official Notices" December 24th.

Birmingham.—February 1st. Stores for the Tramways Department. See "Official Notices" December 31st.

Dublin.—January 14th. Electric lighting scheme for the new Crookaling Sanatorium of the Dublin Joint Hospital Board. Patrick Nally, Clerk to the Board, Municipal Buildings, Cork Hill, Dublin.

Eccles.—January 15th. 150-KW. steam engine and D.C. dynamo for the Corporation electricity undertaking. See "Official Notices" December 24th.

Erith.—January 10th. High-tension three-phase alternating-current switchboard for the U.D.C. See "Official Notices" December 24th.

London.—I.E.E.—January 10th. The Council of the Institution of Electrical Engineers is inviting tenders for the interior wiring and fittings for lighting and power at its new premises. See "Official Notices" December 24th.

STEPNEY. — January 24th. Boilers and accessories; turbo-generator accessories; converting plant; switchgear, &c., for the B.C. Electricity Supply Committee. See "Official Notices" to-day.

Plymouth.—January 25th. Stores for the Corporation Electricity and Street Lighting Departments. See "Official Notices" to-day.

CLOSED.

Aberdeen.—Among the tenders accepted for the year by the Corporation Electricity Committee are:—

Brass, lead, &c.—Messrs. John Blaikie & Sons.
Cast-iron.—Messrs. James Abernethy & Co.
Tubes and fittings.—Messrs. D. Richmond & Co.

Bristol.—The T.C. has accepted the tender of Henley's Telegraph Works Co., Ltd., for joint and junction boxes, at £233 3s. 6d.

Carlin.—The Skinningrove Iron and Steel Co., of Carlin, have placed another order with Ehrhardt & Sehmer for a further 1,650-H.P. gas engine, to be direct-coupled to an electric generator. This is the third repeat order received from this company during the current year.

Derby.—The T.C. has accepted the tender of Messrs. Newton Bros., Derby, for a booster, at £240.

Eccles.—The T.C. has accepted the tender of the British Westinghouse Electric and Manufacturing Co., Ltd., for the annual supply of electricity meters.

London.—The British Central Electrical Co. have secured a contract from the Port of London Authority for 50 of their Guardian hand lamps.

HAMMERSMITH.—The Electricity Committee received the following tenders for the supply of switch panels required, in quantities of not less than six:—

Spagnoletti, Ltd.	(accepted)	£9	7 6
Switchgear Co., Ltd.		9	8 6
British Westinghouse Co., Ltd.		10	6 0
Cowans, Ltd.		10	7 0
R. W. Blackwell & Co., Ltd.		16	0 0
General Electric Co., Ltd.		17	10 0

The tender of J. B. Garnham has been accepted for the purchase of scrap copper, at £57 10s. 6d. per ton, and for rubber cable, at £26 2s. 6d. per ton; and that of F. A. Clark & Son for lead, at £11 5s. 6d.

Salford.—The following tenders have been accepted by the T.C.:—

J. Collier & Co. (Manchester), at £65, for the installation of electric light and bells at Gardner Street Fire Station.
General Electric Co., Ltd., 15 doz. 16-C.P. Robertson carbon-filament lamps, 220 volts, 6s. 9d. per doz.; five doz. 50-C.P. Osram lamps, 220 volts, two doz. 50-C.P. ditto, 110 volts and one doz. 50-C.P. ditto, 75 volts, 4s. 3d. each, less 20 per cent. and 10 per cent.
Smith, Major & Stevens, Ltd. (Salford), at £85 15s., for supplying and fixing complete new single lift and motor, together with the necessary gearing, switches and cable, at Pendleton Town Hall.

Woolwich.—The B.C. received the following tenders for two miles of service cable:—

W. T. Henley's Telegraph Works Co., Ltd. ..	(accepted)	£630
Siemens Bros. & Co., Ltd.		334
W. T. Glover & Co., Ltd...		335
British Insulated and Helsby Cables, Ltd.		341

Electric Matrix-drying Table.—The *Electrical World* illustrates an electric table for drying the matrices used in newspaper printing, and states that the close control of the temperature obtained with electric heating, the rapidity with which the drying is effected, and the technical excellence of the "mats" thus dried, are strong points in favour of the method. Further, as the electric heater can be applied exactly where it is wanted, the room is not heated as with gas or steam, and the electric process is more economical than any other. Printers' electricians on this side of the water may take a hint from this.

FORTHCOMING EVENTS.

Institution of Mechanical Engineers.—Friday, January 7th. At 8 p.m. Papers on "The Application of the Pitot Tube to the Testing of Impulse Water Wheels," by Mr. W. R. Eckart; and "An Account of a Visit to the Power Plant of the Ontario Power Co. at Niagara Falls," by Mr. C. W. Jordan.

Electro-Harmonic Society.—Friday, January 7th. At 8 p.m. At Holborn Restaurant. Smoking Concert.

Institution of Civil Engineers.—Friday, January 7th. At 8 p.m. Students' meeting. Paper on "Oil Fuel," by Mr. D. S. Richardson.

Saturday, January 8th. Students' visit to the National Physical Laboratory.

Tuesday, January 11th. At 8 p.m. Paper on "The Design of Rolling Stock for Smooth-Rail Working on Heavy Gradients," by Mr. F. W. Bach.

Association of Engineers-in-Charge.—Saturday, January 8th. Social. Dance.

Wednesday, January 12th. At 8 p.m. At St. Bride's Institute, E.C. Paper on "Heating and Ventilating of Public Buildings," by Mr. T. H. Aldwinckle.

St. James' Electric Athletic Club.—Saturday, January 8th. At 7.15 p.m. At the Bridge House Hotel, London Bridge, S.E. Smoking concert.

Institution of Mechanical Engineers (Graduates' Association).—Monday, January 10th. At 8 p.m. Paper on "Artesian Water Supply," by Mr. A. D. Salway.

Institution of Electrical Engineers (Manchester Section).—Tuesday, January 11th. At 7.30 p.m. At the University, Manchester. Paper on "The Testing of Rubber for Electrical Work," by Prof. A. Schwartz.

Illuminating Engineering Society.—Tuesday, January 11th. At the Royal Society of Arts. Discussion on "Glare, its Causes and Effects," to be opened by Dr. J. H. Parsons.

Institution of Electrical Engineers (Glasgow Section).—Tuesday, January 11th. At 8 p.m. At 207, Bath Street, Glasgow. Paper on "The Most Economical Vacuum for Turbine Power Stations," by Mr. R. M. Neilson.

Institution of Electrical Engineers (London).—Thursday, January 13th. At 8 p.m. At the Institution of Civil Engineers. Second Kelvin Lecture, on "Lord Kelvin's Work in Telegraphy and Navigation," by Prof. J. A. Ewing.

THE ELECTRICAL ENGINEERS
(LONDON DIVISION).

THE following orders are issued:—

Commanding Officer—COL. R. E. B. CROMPTON, C.B.

Monday, January 10th.—"A" Company. Technical drill, 7 to 9.30 p.m.
Tuesday, January 11th.—"B" Company. Technical drill, 7 to 9.30 p.m.
Wednesday, January 12th.—Gymnasium, 6.30 to 9.30 p.m.
Thursday, January 13th.—"C" Company. Technical drill, 7 to 9.30 p.m.
Friday, January 14th.—"D" Company. Technical drill, 7 to 9.30 p.m.
Saturday, January 15th.—No week-end run.

(Signed) P. H. CAMPBELL Capt. R.E. and Adjutant.
For O.C. E.E., L.D.

NOTES.

New Laboratories at Dundee College.—For the teaching of electrical engineering and physics on modern lines, it is essential not only that the scientific equipment should be of the most elaborate nature, but that the buildings, in which the apparatus is to be used, should in themselves be constructed on lines calculated to counteract, or at least to reduce to a minimum, internal or external influences likely to disturb the accurate working of the apparatus.

In this respect it may be claimed that the new electrical engineering and physics laboratories at the Dundee University College are on correct and up-to-date lines, every detail of construction in any section of the buildings having been carefully considered and carried out with a view to rendering accurate the experiments likely to be carried out in those parts of the buildings.

In the lecture room, for instance, the use of iron or steel has been rigorously avoided, gun-metal and copper being utilised instead, while in the electrical laboratory, a solid gable wall has been chosen for the suspension of the most delicate instruments, and where it has been found necessary to suspend instruments on the other walls of the room, their supports enter the wall without touching the surrounding woodwork. By these contrivances, magnetic and vibratory disturbances will be avoided, and greater satisfaction and efficiency obtained from the experiments.

Externally the new buildings are very pleasing to the eye, and add greatly to the architectural merit of the College buildings.

There are two separate self-contained blocks; the larger, costing approximately £12,500, is to be the physics laboratory proper, while the smaller, costing £4,000, will form the electrical engineering laboratory.

The physics laboratory is a structure of three floors and a basement. On the ground floor is the lecture room, with accommodation for 130 to 140 students, and the building is so designed that when all the doors are open an uninterrupted view may be had from one end of it to the other. This, of course, will prove of great value when experiments are being carried out on the radiation of heat and light.

The lecture room is also fitted with electrical appliances for heavy and small currents, and a platform gallery for the suspension of diagrams and apparatus.

At the extreme north end of the building is situated the electrical laboratory, the standardising room and an electrical distribution board.

The first floor contains a range of class rooms similar to that below, and a spectroscopical research room. The upper flat is set apart for a photographic dark room and physical laboratories. Access may also be had to the roof for experiments in aerodynamics. In the basement is the magnetic room, the liquid-air plant, and a room designed for conducting experiments demanding a steady temperature for lengthened periods.

In the electrical engineering laboratory are transformers which transform the Corporation supply from 200 volts to 1,000 volts for use in the physics laboratory. The dynamo room contains a number of machines for experimental and power purposes, for direct and alternating currents, from 10 H.P. downwards. There are also a photometric room, a well-fitted lecturer's room, and a direct-current laboratory.

The physics laboratory is the gift of Mr. Andrew Carnegie, LL.D., and the laboratory of electrical engineering is a gift from Mrs. Garden and Miss Peters, in commemoration of their brother, the late Lord Dean of Guild Peters.

Loans for Electric Lighting.—The Local Government Board has just issued Part II of its annual report, dealing, amongst other things, with loans to County Councils and urban and rural authorities. It is stated that in the year under review, ending March 30th last, £1,370,268 was loaned to urban district councils for purposes under the Electric Lighting Act, 1882, and £7,000 to rural councils. This total of £1,377,268 compares with £1,247,781 in the preceding year. Since 1889 loans amounting to £25,550,546 have been sanctioned. The whole of this amount was required by town councils and urban district councils, with the exception of two loans of £20,000 and £7,000 sanctioned to be raised by the rural district council of Neath in 1905 and 1908 respectively. During the year under review amounts were sanctioned to the following authorities:—

Abertillery U.D.C.	£10,363	Ilford U.D.C.	£26,927
Accrington	7,500	Kingston-upon-Hull	36,967
Aston Manor	21,640	Kingston-on-Thames	11,963
Bangor	1,000	Leek U.D.C.	8,225
Barking Town U.D.C.	2,400	Leyton U.D.C.	5,645
Barrow-in-Furness	5,000	Liverpool	132,840
Beckenham U.D.C.	24,180	Llandudno U.D.C.	2,641
Bexhill	9,430	Long Eaton U.D.C.	8,696
Birmingham	28,041	Loughborough	1,865
Blackpool	5,000	Lowestoft	2,601
Bridgend	5,500	Manchester	61,044
Brighouse	6,140	Monmouth	9,482
Burnley	18,114	Norwich	1,450
Burslem	10,084	Nuneaton	2,425
Buxton U.D.C.	2,540	Oldham	1,500
Canterbury	4,381	Peterborough	1,006
Carlisle	4,000	Pontypridd U.D.C.	3,644
Cheltenham	360	Ramsbottom U.D.C.	26
Clacton U.D.C.	4,000	Rawtenstall	33,800
Colne	4,170	Redditch U.D.C.	1,500
Colwyn Bay U.D.C.	2,000	Rochdale	21,350
Coventry	39,178	Rotherham	3,820
Crewe	2,800	St. Anne's-on-Sea U.D.C.	3,500
Cromer U.D.C.	4,837	St. Helens (Lancs.)	9,439
Croydon	13,500	Salford	15,282
Darlington	1,040	Sheffield	34,314
Dartford U.D.C.	1,232	Southampton	6,500
Darwen	4,057	Southend-on-Sea	18,144
Derby	15,197	Southport	1,500
Dorking U.D.C.	10,820	South Shields	11,251
Dover	9,774	Stockport	10,500
Eastbourne	7,000	Stoke-upon-Trent	7,383
Eccles	12,741	Stretford U.D.C.	59,769
Elland U.D.C.	2,000	Surbiton U.D.C.	4,943
Erith U.D.C.	4,845	Sutton Coldfield	320
Exeter	8,100	Taunton	1,670
Fareham U.D.C.	10,000	Tonbridge U.D.C.	3,653
Farnworth	6,590	Wakefield	2,052
Finchley U.D.C.	23,959	Walsall	3,400
Frome U.D.C.	9,595	Walthamstow U.D.C.	17,410
Gravesend	7,350	Wednesbury	9,926
Great Yarmouth	2,000	West Ham	64,317
Halifax	1,019	Weymouth & Melcombe Regis	7,036
Handsworth (Staffs.) U.D.C.	21,800	Whitby	30,277
Hanley	20,642	Wigan	6,836
Harrogate	1,712	Willesden U.D.C.	13,727
Hebden Bridge U.D.C.	500	Wimbledon	22,031
Hereford	1,500	Wolverhampton	6,000
Holyhead U.D.C.	2,065	Worcester	9,086
Hornsey	10,000	Worthing	1,960
Hoylake and W. Kirby U.D.C.	1,909	Wrexham	575

Cables on Prussian Railway Property.—The Prussian Minister of Public Works has just given consent to regulations in regard to the location of cables or conductors carrying heavy current on railway property, with the exception of the working conductors for electric railways. The regulations, which came into force on January 1st, 1910, are to be added to the agreements between electric supply works and the State railway administration, but they do not relate to cables or conductors which approach railway property, these being deferred for future consideration. In the course of a letter addressed to the railway authorities, the Minister informs them that they are always to bear in mind, when forming an opinion on proposals for the admission of cables on railway land, that as these cables are almost wholly of very great public utility and importance, they should be hindered as little as possible. It is therefore advisable, it is added, to treat such proposals kindly, and to restrict objections and conditional consents to the least degree necessary.

Xmas Festivities.—The Walthamstow Tramways Employés Recreation Club gave their second annual Children's Xmas Treat on Thursday, December 30th, 1909, at the Conway Hall, Walthamstow, when nearly 200 children were provided with a substantial tea, and an evening's entertainment. Before leaving, every child was presented with a gift from a gigantic Xmas Tree, together with a bag of sweets, oranges, crackers, &c. Votes of thanks to the friends who had assisted in the treat, and to the entertainers were proposed by Mr. Wm. Murray, tramways manager, and carried with great acclamation.

Institution and Lecture Notes.—UNIVERSITY COLLEGE, LONDON.—A postgraduate course of lectures on "Steam Turbines," by Messrs. W. J. Goudie, B.Sc., and E. G. Izod (of Messrs. Willans & Robinson) will begin on January 21st.

SOCIETY OF ENGINEERS.—A dinner will be held at the Waldorf Hotel on Wednesday, January 19th, to celebrate the amalgamation of the Society of Engineers (established 1854) and the Civil and Mechanical Engineers' Society (founded 1859). A number of distinguished guests have already notified their intention of being present. In view of the unique character of the event, and the fact that ladies may be present, a good attendance is anticipated, especially as this is the inaugural function in connection with the new Society which has been formed by the union of the two Societies.

Electricity v. Gas for Train Lighting.—A shocking accident occurred at the small station of Uhersko, between Pardubatz and Chotzau, early in the Christmas holidays. The express which left Prague at 7 20 was going at a speed of 50 miles an hour, when it ran into a goods train which was being shunted. The effect of the impact was terrific, and under the wreckage of the train, which was very full, nine dead and sixteen wounded were buried. Immediately after the accident the escaping gas was ignited and set fire to the train, and it was only after the fire had been extinguished that it was possible to rescue the survivors. It is noteworthy that a number of the deaths were due to suffocation. It will be remembered that in our issue of December 3rd we drew attention to the danger of gas, and the above accident fully confirms what we then prophesied. We trust that it will not require the sacrifice of a considerable number of British lives to induce our railway companies to adopt electric lighting.

Concert.—The fifth annual smoking concert organised by the Drawing Office of the B.T.-H. Co. was held at the Grand Hotel, Rugby, on Wednesday, December 22nd. There were over 80 present, and the proceedings were enthusiastic. Mr. C. C. Wharton, chief of the Drawing Office, occupied the chair, supported by Mr. Charles Hutchinson.

Theft of Wire.—At Handsworth, on 24th ult., Joseph Blewitt was sentenced to two months' imprisonment for stealing copper wire belonging to the Hamstead Colliery Co. On the previous Saturday evening the electric lighting of a residence served from the colliery power supply failed, and on examination by the electrician it was found that the cable had been broken down and about 30 yards of wire apparently twisted off.

Appointments Vacant.—Switchboard attendant for the Paisley electricity works. Junior assistant engineers for the Newcastle-upon-Tyne Electric Supply Co. (10s. per week first year, 20s. second year). See "Official Notices" to-day.

The Aberdeen Arbitration Dispute.—The Corporation Electricity Committee has taken opinion of Counsel in the dispute over the arbiter's award as to the supply of electricity to the Suburban Tramways Co. Mr. C. Scott Dickson, K.C., and Mr. Hugh P. Macmillan, advocate, in answer to the question submitted to them, state:—In our opinion the appropriate procedure for enforcing the award would be to raise an action against the company concluding for payment of a sum calculated on the basis of the award, and representing the amount due at the date of raising the action. In view, however, of the questions which have been raised by the company as to the validity of the award, and the possible effect which its invalidity might have on the subsistence of the agreement, we do not think that the grounds of action should be confined to the award. In our opinion alternative grounds of action should be stated, and in particular, *quantum meruit*. We are of opinion further that the judgment would probably afford the parties a basis on which to regulate their relations for the future. The whole matter will come before the Town Council.

An Australian Claim.—According to the *British Australasian*, Francis Edwin Bradford, electrical engineer, of South Melbourne, who claimed £3,500 damages from the Victorian Government for alleged breach of contract in connection with the proposed electrification of the suburban railways, was on November 18th awarded £1,328 damages and costs.

Fixation of Nitrogen in Norway.—A large block of ordinary shares (108,000) in the Société Norvégienne de l'Azote et de Forces Hydro-Electriques is being introduced on the Paris Stock Exchange. The company, whose headquarters are at Notodden, was formed in 1905, principally for the extraction on the Birkeland-Eyde system of nitrogen from the atmosphere and the winning of by-products, including calcium cyanamide. The original capital comprised £250,000 in 8 per cent. non-cumulative preference shares, and £166,680 in ordinary shares. In consequence of an agreement entered into in 1907 with the German group—the Baden Anilin und Soda Fabrik, the Farben Fabrikvorm. Fr. Bayer and the Gesellschaft fur Anilin Fabrikation—a further issue of £149,900 in ordinary shares was offered to the shareholders, and £1,080,000 in similar shares were also issued, whilst an issue of bonds is contemplated in 1910. The Société Norvégienne owns the waterfall and hydro-electric and electrochemical works of Svaelgfors Notodden, which represent 40,000 H.P., are in full operation, and are the largest of the kind in the world. The waterfall of Lienfors, which is situated above Notodden, and is of 15,000 H.P., is at present being brought into use, and the company also owns the Wamma waterfall, where works were commenced in 1907 for the utilisation of 55,000 H.P. The German companies mentioned joined hands for the common use of their existing and future patents in Norway, intending to draw upon waterfalls totalling 400,000 H.P. for this purpose, and for the joint granting of licences in other countries, and two subsidiary companies were accordingly formed. These are the Société Norvégienne de Forces, and the Société Norvégienne des Usines Nitralières, whose shares are held by the German companies. The former, which has a capital of 16,000,000 crowns, has at disposal three waterfalls representing 394,000 H.P.; works for the utilisation of 120,000 H.P. of this total are in progress, and the factory is to be completed at the beginning of 1911. A subsidiary was formed by this company under the title of the Société Norvégienne de Transports, for the construction of a railway connecting with the coast, of a length of 85 miles, and also serving for public use; the line has already been opened for traffic. In the case of the Société des Usines Nitralières, which has a capital of 18,000,000 crowns, it is intended to produce nitrate compounds, and the company holds the patents of the German chemical groups in question, and expects to start the works in the spring of 1911. It is stated that the working results of the Société de l'Azote, at Notodden, have exceeded expectations and have increased by 10 per cent. in the past year, and as the products find a ready sale the company has no stocks. The output of cyanamide realises a slightly higher price than Chilian nitrate, and the great purity of the chemical products is said to make them very lucrative. The net profits earned in 1909 are reported to permit of the payment of the 8 per cent. dividend on the preference shares and a minimum of 5 per cent. on the original ordinary shares. It is added that negotiations are now proceeding for the grant of licences by the German companies both in Europe and in the United States.

Wills.—The late Baron G. J. de Reuter, left £13,809. £75,290 was the gross value of the personal estate of the late Dr. Hugh Blackburn, Emeritus Professor of Mathematics at Glasgow University.

Dr. Ludwig Mond under his will has directed his trustees to set aside £50,000 to the Royal Society of London for endowing research in natural science (more particularly, but not exclusively, in chemistry and physics), and £50,000 for a similar purpose to the University of Heidelberg.

Wireless Torpedo.—The *Daily Mail* reports experiments carried out with a "wireless torpedo," the invention of a young French engineer, M. Gabet. The torpedo is said to be "driven by Hertzian waves," and is expected to develop a speed of twenty-five knots. It can, it is claimed, be directed in its course by an operator on shore or on board a warship until the projectile strikes its objective. Whether it will prove any better than its many forerunners remains to be seen.

OUR PERSONAL COLUMN.

The editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the ELECTRICAL REVIEW *posted as to their movements.*

Central Station Officials.—MR. HEMMING having resigned the position of assistant engineer to the Leek U.D.C. electricity works, a successor is to be advertised for.

The Eccles T.C. has appointed MR. HAROLD F. BARNES, of Portsmouth, as switchboard attendant, in place of MR. W. P. HOOPER (resigned).

MR. E. R. ALEXANDER, assistant engineer at the Stamford electricity works, who has resigned, has been presented by the staff with a pair of silver-mounted carvers and steel in case.

General.—MR. ARTHUR INESON, who has been in the electricity department of the Batley Corporation for the past six years, recently left to take up the position of superintendent of the wiring department at Messrs. Vickers, Sons & Maxim, at Barrow-in-Furness. The employés at the electricity works presented him with a set of books.

MR. SYDNEY MORSE has changed his address from Norfolk Street to Electrical Federation Buildings, Kingsway, London, W.C. Both his telephone No. and his telegraphic address will be unaltered.

DR. G. W. C. KAYE, A.M.I.E.E., has been appointed an assistant in the Metrology Division of the National Physical Laboratory. He was formerly Demonstrator in Physics at the Royal College of Science, and a Sub-lector in Physics at Trinity College, Cambridge.

Obituary.—The death occurred on December 30th of MR. WILLIAM JOHN CUDWORTH, who until very recently occupied the position of chief engineer of the southern division of the N.-E. Railway. He was 61 years of age. Mr. Cudworth was an authority on railway signalling, and during his period of office, important electric and automatic signalling works were carried out on the railway.

A large number of our readers will join with us in an expression of sympathy with MR. EDWARD MANVILLE, M.I.E.E. (of the firm of Kincaid, Waller, Manville & Dawson, of Westminster), in the loss he has sustained by the death of his wife, which occurred on December 30th, at Grove Lodge, Hampstead, after a long and very painful illness. Mrs. Manville was, like her husband, an enthusiastic motorist, but she was also a remarkable horsewoman, was interested in motor-boat racing, and had had practical experience of ballooning. Automobile organisations and the Aero Club counted her among their most accomplished members. The last rites were performed at Newport, Mon.—the home of her father, Col. C. T. Wallis—on Monday, a memorial service being held at St. Mary's, Primrose Hill, London, on the same day.

NEW COMPANIES REGISTERED.

Chapman & Stephenson, Ltd. (106,660).—This company was registered on December 24th, with a capital of £3,000 in £1 shares, to acquire patents for an invention of an improved photometer belonging to H. Chapman, and to carry on the business of electrical engineers, manufacturers and workers in electricity, motive power and light, manufacturers of and dealers in photometers, gauges, &c. The subscribers (with one share each) are:—H. Chapman, Ryecroft Villas, Meersbrook Road, Sheffield, electrical engineer; A. Stephenson, Graystone House, Adwalton, near Bradford, electrical engineer. Private company. The number of directors is not to be less than two or more than three; the first are H. Chapman and A. Stephenson (both permanent, subject to holding 500 shares each); H. Chapman is chairman; qualification, 100 shares; remuneration, £10 per annum, divisible. Each share confers one vote, provided that on any resolution proposing to alter the articles as to said first directors retaining office, or as to H. Chapman holding office as chairman, each of the said first directors (or his proxy when voting against such resolution) shall, while the said director holds 500 shares, have 10 votes for every share held by him. Registered by Jordan & Sons, Ltd., 116-117, Chancery Lane, W.C.

Scottish Power Co., Ltd. (7,385).—This company was registered in Edinburgh on December 27th, with a capital of £160,000 in £1 shares, to purchase, hold, turn to account and dispose of all or any part of the share capital of the Scottish Central Electric Power Co., and all or any of the liabilities of the said company, to construct, purchase, lease or otherwise acquire public or private undertakings of all kinds in the United Kingdom, including in particular light or other railways, electric or other tramways, electric lighting and power supply works, telephonic, telegraphic, gas, water and hydraulic power works, drainage and sanitary works and the like. The subscribers are:—W. P. Gray, Hilview, Davidsons Mains, Midlothian, cashier, 1 share; W. Begg, St. Agnes Cottage Banks, Brechin, clerk, 1 share; D. Robertson, Struan Place, Kinross, clerk, 1 share; W. L. Wilson, Laws Cottage, Duns, clerk, 1 share; J. Bain, 5, Claremont Terrace, Edinburgh, clerk, 1, share; G. Balfour, 22a, College Hill, Cannon Street, London, M.I.C.E., 100 shares; J. Walker, 25, Frederick Street, Edinburgh, chartered accountant, 100 shares. The number of directors is not to be less than three or more than seven; the first are A. W. Tait, J. Walker, G. Balfour and H. Brown; qualification, 100 shares; remuneration as fixed by the company.

Fixed Price Light Co., Ltd. (106,725).—This company was registered on December 30th, with a capital of £10,000 in £1 shares ('00 deferred), to carry on the business of electricians, mechanical engineers, generators and suppliers of electricity for light, heat, motive power or otherwise, &c. The subscribers (with one share each) are:—G. von Chauvin, 356, Caxton House, Westminster, S.W., telegraph engineer; W. Wheeler, 356, Caxton House, Westminster, S.W., accountant; J. S. Haddleston, 356, Caxton House, Westminster, S.W., electrical engineer. Private company. The number of directors is not to be less than two or more than seven; the first are G. von Chauvin and J. S Haddleston; remuneration as fixed by the company. Registered office, Caxton House, Westminster.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

British Tungsten Lamp Co., Ltd. (100,468).—Issue on December 9th of £2,000 debentures, part of series created September 9th, 1909, to secure £7,000, charged on the company's undertaking and property, present and future, except uncalled capital. No trustees. Previously issued of same series: £5,000.

Keighley Electrical Engineering Co., Ltd. (44 893).—A memorandum of satisfaction in full on December 16th, 1909, of debenture dated September 21st, 1899, securing £3,000, has been filed.

Coatbridge and Airdrie Electric Supply Co., Ltd. (89,178).—Mortgage dated December 20th, 1909, to secure £4,700, charged on the company's undertaking and property, present and future, including Coatbridge and Airdrie undertakings and benefit of certain agreements. Holders: County of London Electric Supply Co., Ltd., Moorgate Court, E.C.

CITY NOTES.

Sunderland District Electric Tramways, Ltd.

THE fifth annual general meeting of the shareholders of the above company was held on Tuesday at the Great Eastern Hotel, Liverpool Street, Mr. C. S. Cockburn, J.P., presiding.

The CHAIRMAN, in moving the adoption of the report (see ELECTRICAL REVIEW, December 31st, page 1066), said that the board and the staff at Sunderland had passed through a very trying and anxious 12 months. Two things had been responsible for this; the first, viz., the unprecedentedly wet summer, every tramway company in England had suffered from equally, and many balance-sheets that he had had an opportunity of examining showed disastrous results, entirely attributable to the unfortunate weather. They were not so bad as those companies, but then they had no holiday resort on their system. At the same time, on many occasions when they anticipated and were prepared for large crowds travelling to fêtes, matches, and other outdoor entertainments, the rain came down in torrents, and instead of a bumper traffic, they took even less than they would have done on an ordinary fine Saturday afternoon, without any additional attraction. The other point that had militated against them was one that, he regretted to say, was still with them, and was still in the ascendant, viz., the deplorable state of trade following on the prolonged shipbuilding strike of 18 months ago. The traffic receipts were down £1,319 7s. 6d., entirely attributable to those two causes. This meant that had their traffics only remained stationary, without any increase, instead of a debit of £780 on the year's accounts, they would have shown a profit. Early in the year, the board saw the trend of events and the likelihood of a big traffic decrease, so they, and the staff at Sunderland, at once began to do everything in their power to effect economies and to save all unnecessary expenditure, with the result that on the year's accounts—compared with the year 1908—they had saved in the London office outgoings £266, and at Sunderland £1,293, a total of £1,559. It was entirely owing to these economies that the accounts presented a healthy appearance. Comparing their receipts and expenses with those of 25 other companies, they found that their total receipts per car-mile were 9·475d., as compared with 9·53d. for the 25 other companies. Their total operation costs were 4·260d., as against 4·97d.; their power costs were 1·491d., as against 1·78d.; and their works cost came out at 5·751d., as compared with an average of 6·53d. in the 25 companies he had taken. Referring to the balance-sheet since the last meeting, they had issued £2,500 more prior lien bonds. The sundry creditors were £1,278, as against £5,786 last year, a very considerable reduction. £876 of that item was a loan to the Durham company, which was contracted some years ago, and which was being gradually repaid out of the royalties received. On the other side stock, stores and materials stood at £851, as against £1,395, so it would be seen that they had not put a healthy appearance on their balance-sheet by taking a big stock of materials. The power expenses amounted to £4,097, as compared with £4,280; the operating expenses were £6,532, as against £6,648; repairs and renewals £2,950, against £3,480; management expenses £2,295, as against £2,829, while the traffic receipts amounted to £24,075, as compared with £25,395 in the previous year. The board still felt it would be a good thing if they could carry their passengers into the town, rather than turn them out in the suburbs and make them change cars. During the past year they had continued their efforts to achieve this object, but he regretted to say without success. However, at the present time, he believed every Council and local authority, through whose area their line passed, was petitioning to obtain this concession, and he could only hope that when the Corporation of Sunderland realised from outside sources what an immense boon it would be to the working men of the large district that they served, and that it was not merely from selfish motives that they approached them, they would allow some scheme to be formulated that would benefit themselves and the company and the public at large. Had the past year been a normal one they would have come before the shareholders with a proposal relating to the capital reorganisation of the company. The board were giving this matter their earnest consideration, and he had discussed it with the largest shareholders, both ordinary and preference, but the board felt, and those shareholders agreed, that so long as they were not earning their three debenture interests—even by the small amount the year's workings showed—it was inopportune to discuss the question. As to their future, he confessed he was hopeful, and by nature, his friends told him, he was not an optimist. In the ordinary cycle of events trade would have to revive some time or other. England was not ruined yet, and English energy and business aptitude had not all evaporated. When that time did come their traffic would take a big upward jump, and they would be in a position to deal with such an increase, as during the last few months they had taken advantage of low prices for goods and material, and out of moneys provided by the issue of prior lien bonds they had bought three new cars and practically rebuilt four of the old French cars, so that now they were as good as new; in addition, they had laid down three new loops, which ensured the more expeditious working of their traffic. All this work helped them to run their cars more economically and to keep down their ratio of expenses to receipts. For the past year their costs to receipts worked out at 60·70 per cent., whereas two years ago, when their rolling stock and equipment were in such a deplorable state, the percentage came to the extraordinary figure of 81·16 per cent. During the past year about 350 new houses had been built on the route of their track. He must tell them that the Miners' Eight Hours Act came into operation on January 1st, and he regretted to say that it was causing a good deal of trouble and friction in the district. It was to be hoped that nothing would happen in the way of a general strike, for should such a thing take place it was bound to have a serious effect upon their receipts.

MR. C. EVES seconded the motion.

MR. LEET remarked that the reduction in working expenses was very satisfactory. He hoped it would not be necessary to issue any more prior lien bonds in the coming year, as the total already stood at £10,500.

The CHAIRMAN, in reply, said that the total issue of prior lien bonds authorised was £20,000. They gave an undertaking at the time to the committee which was appointed to thoroughly investigate the matter, that they would not issue more than £15,000 without going to those gentlemen. Personally, he did not think they would have to issue any more of them, and he sincerely hoped they would not. As to the number of cars, there were 33 altogether on the system; 15 of them were the old French vehicles, which had given them so much trouble, and which were gradually being put in order.

The report was then adopted.

Melbourne Tramway and Omnibus Co., Ltd.—For the quarter ended December 31st a dividend of 4½d. per share (at the rate of 15 per cent. per annum) is to be paid.

MARKET QUOTATIONS.

Wednesday, January 5th.

CHEMICALS, &c.		Latest Price.	Fortnight's Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	..
a „ Nitric	„	22/-	..
a „ Oxalic	„	28/-	..
a „ Sulphuric	„	5/6	..
a Ammoniac, Sal	„	42/-	..
a Ammonia, Muriate (crystal)	per ton	£29	..
a „ „	„	£30	..
a Bleaching powder	„	£5 10	..
a Bisulphide of Carbon	„	£18	..
a Borax	„	£16	..
a Ferro-Silicon (50 %)	„	£10	10/- dec.
a Copper Sulphate	„	£18 10	..
a Lead, Nitrate	„	£28	10/- dec.
a „ White Sugar	„	£28 10	..
a „ Peroxide	„	£32	..
a Methylated Spirit	per gal.	2/6	..
a Potassium, Bichromate, in casks	per lb.	3¾d.	..
a Potash, Caustic (75/80 %)	per ton	£20	..
a „ Chlorate	per lb.	3¾d.	..
a „ Perchlorate	„	3⅝d.	..
a Potassium, Cyanide	„	7d.	..
a Shellac	per cwt.	75/-	..
a Sulphate of Magnesia	per ton	£4 10	..
a Sulphur, Sublimed Flowers	„	£6 10	..
a „ Recovered	„	£5 10	..
a „ Lump	„	£5	..
a Soda, Caustic (white 70 %)	„	£11	..
a „ Chlorate	per lb.	3⅝d.	..
a „ Crystals	per ton	£3 5	..
a Sodium Bichromate, casks	per lb.	3d.	..
a „ Cyanide (basis 100 %)	„	7d.	..
METALS, &c.			
b Aluminium Ingots, in ton lots	per ton	£75	..
b „ Wire, in ton lots	„	£112	..
b „ Sheet, in ton lots	„	£120	..
p Babbitt's metal ingots	„	..	..
c Brass (rolled metal 2" to 12" basis)	per lb.	7⅛d.	⅛d. inc.
c „ Tube (brazed)	„	9½d.	⅛d. inc.
c „ „ (solid drawn)	„	7⅞d.	⅛d. inc.
c „ Wire, basis	„	6⅞d.	⅛d. inc.
c Copper Tubes (brazed)	„	9½d.	⅛d. inc.
c „ „ (solid drawn	„	9½d.	⅛d. inc.
g „ Bars (best selected)	per ton	£75	£2 inc.
g „ Sheet	„	£75	£2 inc.
g „ Rod	„	£75	£2 inc.
e „ (Electrolytic) Bars	„	£64	£3 inc.
e „ „ Sheets	„	£80	£3 inc.
e „ „ Rod	„	£68 10	£3 inc.
e „ „ H.C. Wire	per lb.	8¾d.	⅛d. inc.
f Ebonite Rod	„	3/3	..
f „ Sheet	„	3/-	..
n German Silver Wire	„	1/6	..
h Gutta-percha, fine	„	5/6 to 6/6	..
h India-rubber, Para fine	„	7/7½	1d. inc.
i Iron Pig (Cleveland warrants)	per ton	51/3	3d. dec.
l „ Wire, galv. No. 8, P.O. qual.	„	£14	..
g Lead, English Ingot	„	£14 to £14 2 6	inc.
m Manganin Wire No. 28	per lb.	6/6	..
g Mercury	per bot.	£9 14	..
d Mica (in original cases) small	per lb.	6d. to 1s.	..
d „ „ „ medium	„	2/6 to 4/-	..
d „ „ „ large	„	4/6 to 8/6	..
p Phosphor Bronze, plain castings	„	..	..
p „ „ rolled bars & rods	„	..	..
p „ „ rolled strip & sheet	„	..	..
o Platinum	per oz.	120/-	variable.
e Silicium Bronze Wire	per lb.	9½d.	½d. inc.
r Steel Magnet, in bars	per ton	£55	..
g Tin, Block (English)	„	£150 to £151	dec.
n „ Wire, Nos. 1 to 16	per lb.	1/10	..
p White Anti-friction Metals:— "White Ant" brand	per ton	..	..
k Zinc, Sh't (Vieille Montagne bnd.)	„	£27	..

Quotations supplied by—

a G. Boor & Co.
b The British Aluminium Co., Ltd.
c Thos. Bolton & Sons, Ltd.
d F. Wiggins & Sons.
e Frederick Smith & Co.
f India-Rubber, Gutta-Percha and Telegraph Works Co., Ltd.
g James & Shakspeare.
h Edward Till & Co.
i Bolling & Lowe.
k Morris Ashby, Ltd.
l Richard Johnson & Nephew, Ltd.
m W. T. Glover & Co., Ltd.
n P. Ormiston & Sons.
o Johnson, Matthey & Co., Ltd
r W. F. Dennis & Co.

STOCKS AND SHARES.

Tuesday Afternoon.

THE turn of the year brought a fair amount of business into the Stock Exchange, while the expectations of money becoming cheaper contributed to a general recovery amongst investment securities. Dividend money has been flowing with some degree of freedom into the markets, and were it not for the political uncertainty, it is declared that the Stock Exchange would be by now extremely well occupied. The nearness of the political fight, however, certainly exercises a restraining influence over business in the markets.

Where the trace of the investor is most manifest may be seen by reference to the prices of a number of the Debenture stocks quoted *ex* dividend within the last few days. It will be noticed that only part of the full amounts of the interest payments are in many cases deducted. The demand for good securities is sufficiently keen to maintain quotations at better levels, relatively, than they stood at before the marking of the prices *ex* dividend.

Home Railway stocks made a very good start in the New Year, but failed to hold the full amount of improvement then scored. Electrical stocks, however, are firm to good. The Central Londons have material rises to their credit, and in the case of this company the Deferred may, it is hoped, get 2¾ per cent., against 2½ per cent. paid a year ago.

The price of the stock stands at 49, which includes the coming dividend, so that, if the distribution is 2½ per cent., a purchase at the current price would be equal to buying a 5 per cent. stock at 93, *ex* dividend, with very fair prospects of improvement if the Anglo-Japanese Exhibition at Shepherd's Bush this summer is anything like a success.

On City and South London Ordinary stock a dividend at the rate of 1¾ per cent.—being an advance of ¼ per cent.—is anticipated, and the price of the stock has hardened to 33½. Metropolitan Consolidated improved a trifle, but Districts are easier. To work out the figures required to bring District Ordinary stock into the rank of dividend-payers is to discover the futility of even hoping for such a thing, under the present conditions of capital, for many years to come.

The Electricity Supply division is almost unaltered, except for the various interest and dividend deductions. Central Electric Supply Debenture stock rose a point. London Electric Preferences are ⅛ lower. Those are really the only noticeable movements. Mexican Light and Power 5 per cent. bonds have stiffened somewhat, and Mexico Trams enjoyed a rise of 3 points, Rio Trams gaining 2¼ at 94¼, and Sao Paulo hardening to 153½, *ex* 2½ dividend. Canadian General at 116 has recovered more than its dividend, and the Preference at 117½ remains very firm.

Telegraph issues are noticeable, mainly for the regaining of part of the dividend deductions. Anglo-American Telegraph Deferred fell away, on less optimistic prophecies as to the dividend due next month. The market now professes to look for 1¼ per cent. as the top figure. Eastern Extension shares rose 5s., and this group, as a whole, is very steady. National Telephone Preferences are good. Globe Telegraph Ordinary have 2s. 6d. rise to their credit, and Marconi's at 14s. 4½d. are $\frac{5}{32}$ higher.

London United Tramways Debenture is 59½ *ex* dividend, and British Westinghouse 4 per cent. Debenture at 48 is also *ex*. So, too, is Brush Second Debenture at 27. These three securities are now yielding high percentages on money employed at current quotations; it is, perhaps, hardly necessary to add that the higher the return, the greater the risk. Tramway and traction descriptions are quiet, and the manufacturing division is uninteresting. Monday's fire at the Edison & Swan building was not reflected in the prices of the company's shares. Rubber issues have been extremely strong, and in some hitherto bullish quarters the opinion is expressed that the rise in rubber shares has gone quite far enough for the present.

Belgian Enterprise in Russia.—The Société d'Electricité d'Odessa is the title of a new company which has now been formed in Brussels to take over the contract arranged between M. R. Lihody and the City of Odessa, for the supply of light and power in that city, which is said to have received the sanction of the Duma. The share capital amounted to £320,000 in 80,000 ordinary £4 shares, and 60,000 founder shares of non-defined nominal value. Of the former the Société Générale Belge d'Entreprises Electriques has subscribed for 20,400; the Société Financière de Transports, 12,000; the Gesellschaft fur Elektrische Unternehmungen, of Berlin, 12,000; and the Compagnie Mutuelle de Tramways, 5,000; whilst the balance has been taken up by other Belgian banks and electrical companies. The founder shares, which have been alloted to the promoters, are entitled to 50 per cent. of the surplus profits remaining after 5 per cent. has been paid on the ordinary shares, and after appropriation has been made to the legal reserve fund.

R. Waygood & Co., Ltd.—The directors have declared a dividend of 6 per cent. per annum on the preference shares for the six months ending January 15th.

City of London Electric Lighting Co., Ltd.—Warrants in payment of the half-year's interest to December 31st on £400,000 first debenture stock, and £300,000 second debenture stock, have been posted.

Western Union Telegraph Co.—This company had a surplus of $18,017,999 on September 30th last, and by adding the net estimated returns for the quarter ending December 31st, 1909, and deducting interest on bonded debt, this sum at the end of 1909 stood at $19,584,936.

Bank Rate.—The Bank Rate was yesterday reduced to 4 per cent.

SHARE LIST OF ELECTRICAL COMPANIES

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. *	Dividends for the last four years. 1906.	1907.	1908.	1909.	Closing Quotations Dec. 28th	Closing Quotations Jan. 4th.	Business done week ended Jan. 4th, 1910. Highest.	Lowest.	Rise + or Fall —	Present Yield per cent. £ s. d.
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	Nil	Nil	Nil	..	3⅜ — 3¾	3⅜ — 3¾	..	..	..	Nil.
186,700	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	5 %	5 %	5 %	5 %	100 —103	99 - 102 xd	..	..	..	4 18 0
$131,551,400	American Telephone & Telegraph, Cap. Stock ..	$100	8 %	8 %	8 %	8 %	144 —146	143 —145 xd	..	..	..	5 10 5
$58,000,000	Do. Collat. Trust, 4% Bonds, 1 to 28,000 and 53,001 to 78,000	$1000	4 %	4 %	4 %	4 %	96 — 98	94 — 96 xd	..	..	..	4 3 4
558,460	Anglo-American Telegraph	Stock	3⅞%	3⅞%	£3 4s.	..	60 — 62	60 — 62	60½	60	..	5 8 4
3,220,770	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6 %	..	100 —101	100 —101	1 10⅜	100	..	5 18 0
3,220,770	Do. do. do. Deferred	Stock	1⅜	1 %	8/-	..	22 — 22½	21½— 21⅝	21⅛	21⅛	— ⅛	1 17 0
47,725	Anglo-Portuguese Tel., 5 % Mort. Deb. Stock Red.	100	5 %	5 %	5 %	..	101 —103	101 —103	..	..	..	4 17 1
44,000	Chili Telephone, Nos. 1 to 44,000	5	8 %	8 %	8 %	..	7⅞ — 8⅛	7⅞ — 8⅛	..	..	..	4 18 6
2,431,350	Commercial Cable, Sting. 500 year 4% Deb. Stk. Red.	Stock	4 %	4 %	4 %	4 %	86 — 88	85 — 87 xd	86⅜	..	..	4 12 0
16,000	Cuba Telegraph	10	6 %	6 %	6 %	..	8⅝ — 9⅛	8⅝ — 9⅛	..	..	..	6 9 9
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	..	17 — 18	17 — 18	..	..	..	5 11 1
12,981	Direct Spanish Telegraph, Ord.	5	4 %	4 %	4 %	..	3 — 3⅛	3 — 3⅛	..	..	..	5 14 8
6,000	Do. do. 10 % Cum. Pref. ..	5	10 %	10 %	10 %	..	8 — 8½	8 — 8½	8¼	..	..	6 5 0
80,000	Do. do. 4½ % Debs.	50	4½%	4½%	4½%	4½ %	100¼—102½	99 —101 xd	..	..	..	4 9 1
60,710‡	Direct United States Cable	20	4½%	4½%	4½%	..	13 — 13⅛	13 — 13⅛	13⅛	..	..	6 4 7
39,500‡	Direct W. India Cable, 4½ % Reg. Deb., 1 to 1,900, R.	100	4½%	4½%	4½%	4½ %	100 —102	98 —100 xd	..	..	..	4 10 0
4,000,000	Eastern Telegraph, Ord. Stock..	Stock	7 %	7 %	7 %	..	134 —137	134 —137	136	135½	..	5 2 2
2,000,000	Do. 8½ % Pref. Stock..	100	8½%	8½%	8½%	..	ε5 — 87	85 — 87	85½	..	..	4 0 6
1,396,706	Do. 4 % Mort. Deb. Stock. Red. ..	Stock	4 %	4 %	4 %	..	102 —104	102 —104	..	..	..	3 16 11
800,000	Eastern Extension, Australasia, and China Tele	10	7 %	7 %	7 %	..	11⅞ — 12¼	12 — 12½	12⅜	12⅛	+ ⅛	5 12 0
752,400	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	..	102 —104	102 —104	..	..	..	3 16 11
200,000‡	East. & S. Afric. Tel., 4 % Mt Db. Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	..	100 —102	99 —101	..	..	—1	3 19 8
181,127	Globe Telegraph and Trust	10	5½%	5½%	5½%	..	10½ — 10⅝	10⅜— 10⅝	10⅛	10⅛	+ ⅛	5 6 1
181,127	Do. do. 6 % Pref..	10	6 %	6 %	6 %	..	13½ — 13⅝	13½ — 13⅝	..	..	..	4 7 8
150,000	Great Northern Telegraph, of Copenhagen.. ..	10	30 %	20 %	18 %	..	29⅛ — 30⅛	29⅛ — 30⅛	30⅛	30⅛	..	5 18 0
5,000‡	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,900, Red.	100	4½%	4½%	4½%	4½%	100 —102	98 —100 xd	..	..	..	4 10 0
17,000	Indo-European Telegraph	25	18 %	18 %	18 %	..	51 — 53	50½— 52½	51¼	50½	— ½	7 2 10
$41,880,400	Mackay Companies Common	$100	3½%	4 %	4 %	..	93 — 95	93 — 95	..	..	..	4 4 3
$50,000,000	Do. do. 4% Cum. Pref.	$100	4 %	4 %	4 %	..	78 — 80	78 — 80	..	..	..	5 0 0
894,190	Marconi's Wireless Telegraph	1	Nil	Nil	Nil	..	⅛— ⅝	⅜— ⅝	14/4½	12/6	+ 5/32	Nil
72,680	Monte Video Telephone Co., Ltd. Ord.	1	6 %	6 %	6 %	..	⅜— ⅝	⅜— ⅝	..	..	..	6 8 0
86,492	Do. do. do. 5 % Pref. ..	1	5 %	5 %	5 %	..	⅜— ⅝	⅜— ⅝	..	..	..	5 6 8
2,295,000	National Telephone, Pref. Stock	100	6 %	6 %	6 %	..	106½ 108	106½ —108	107¾	107¼	..	5 11 1
3 795,000	Do. do. Def. Stock	100	5 %	6 %	6 %	..	123 —125	123 —125	125¾	123	..	4 16 0
15,000	Do. do. 5 % Cum. 1st. Pref.	10	6 %	6 %	6 %	..	10½— 11	10⅝— 11⅛	11	..	+ ⅛	5 8 4
15,000	Do. do. 6 % Cum. 2nd Pref.	10	5 %	6 %	6 %	..	10¼— 10⅝	10¼— 11	..	..	+ ¼	5 9 1
250,000	Do. do. 5 % Non-cum. 3rd P., 1 to 250,000	5	5 %	5 %	5 %	..	5 7/16— 5 9/16	5 7/16— 5 9/16	5 15/32	..	..	4 8 7
2 000,000	Do. do. 5½ % Deb. Stock Red. ..	Stock	5½%	5½%	5½%	5⅜%	96½ —100½	97 — 99 xd	..	..	..	3 10 9
1,988,598	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	100½ -102½	98½—100½ xd	..	..	..	3 19 7
179,813	Oriental Telep. and Elec. 1 to 171,504, fully paid ..	1	7 %	8 %	8 %	..	1⅜ — 1½	1⅜ — 1½	27/6	..	..	5 5 9
50,000	Do. do. do. 6 % Cum. Pref.... ..	1	6 %	6 %	6 %	..	1 5/16— 1 7/16	1 5/16— 1 7/16	..	..	..	4 14 9
99,100	Do. do. do. 4 % Red. Deb. Stock ..	100	4 %	4 %	4 %	4 %	87½ — 89½	86 — 88 xd	..	..	..	4 10 11
99,400	Pacific & European Tel., 4 % Guar. Debs., 1 to 1,000	10	4 %	4 %	4 %	..	100 —102	100 —102	100½	100¼	..	3 18 5
11,889‡	Reuter's	8	5 %	5 %	5 %	..	7⅞ — 8⅛	7⅞ — 8⅛	..	..	..	4 18 9
145,955	Telephone Co. of Egypt, 4½ % Deb. Red.	100	4½%	4½%	4½%	4½ %	101 —103	99 —101 xd	..	..	..	4 9 1
8,042	Submarine Cables Trust	Cert.	6 %	6 %	6 %	..	129 —132	129 —132	..	..	..	4 7 5
120,000	United River Plate Telephone	5	8 %	8 %	8 %	..	7 — 7⅛	6⅞— 7⅛ xd	7 3/4	6 13/16	..	5 12 8
40,000	Do. 5 % Cum. Pref., Nos. 1 to 40,000	5	5 %	6 %	5 %	..	5⅛ — 5⅜	5⅛ — 5⅜ xd	..	..	..	4 8 11
80,008	W. Coast of America, 1 to 30,000 & 55,001 to 55,008	2½	2½%	2½%	2½%	..	1⅜ — 1⅝	1⅜ — 1⅝	..	..	— ⅛	3 1s 4
150,000	Do. 4 % Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	4 %	4 %	4 %	4 %	100 —102	98 —100 xd	..	..	..	4 0 0
277,980	Western Telegraph, Ltd., Nos. 1 to 207,980.. ..	10	7 %	7 %	7 %	..	13⅝— 14⅛	13⅝— 14 xd	13⅞	..	..	b 2 11
800,000	Do. do. 4 % Deb. Stock Red. ..	100	4 %	4 %	4 %	4 %	103 —105	101 —103 xd	101½	101	..	3 17 8
88,931	West India and Panama Telegraph	10	Nil	Nil	Nil	..	⅜— ¾	⅜— ¾	..	..	..	Nil
84,568	Do. do. 6 % Cum. 1st Pref.	10	8 %	6 %	6 %	..	8¾— 9¼	8¾— 9¼	9	8¾	..	6 9 9
4,669	Do. do. 6 % Cum. 2nd Pref.	10	Nil	£2 6	15 %	..	8 — 9	8 — 9	..	..	..	6 13 4
80,000‡	Do. do. 5 % Debs., Nos. 1 to 1,800 ..	100	5 %	5 %	5 %	5 %	102 —104	100 —102 xd	..	..	..	4 18 0

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

640,000	Anglo-Argentine Trams, 5 % Cum. 1st Pref., 1 to 640,000	5	..	..	..	..	4⅝— 4⅞	4½— 4⅝ xd	92/6	90/-	..	5 5 3
800,000	Do. 5 % 2nd Pref., 800,001 to 1,300,000	5	..	..	..	..	4⅝— 4⅝	4½— 4½ xd	..	..	..	5 11 1
978,230	Do. 4 % Deb. Stock	Stock	..	..	4 %	4 %	92 —93½	90½ - 92 xd	93½	90¾	..	4 7 0
332,387	Auckland E. Trams, 5 % 1st Mort. Deb. Stock ..	..	5 %	5 %	5 %	5 %	104 —107	102 —105 xd	..	..	..	4 15 3
380,000	Babcock & Wilcox, 1 to 380,000	1	20 %	20 %	20 %	..	4⅜— 4⅝	4⅜— 4⅝	95/-	..	..	4 8 9
100,000	Do. do. 6 % Cum. Pref., 1 to 100,000 ..	1	6 %	6 %	6 %	..	1 7/16— 1 9/16	1 7/16— 1 9/16	..	..	..	3 19 2
60,000	British Aluminium, Ord., 1 to 40,000	5	7 %	7 %	Nil	..	1— 1	1— 1	..	..	..	Nil
60,000	Do. do. 7 % Cum. Pref.	5	7 %	7 %	3½%	..	1⅜— 2⅛	1⅜— 1⅞	..	..	— ⅛	9 1 2
40,100	Do. do. "A" 6 % Cum. Pref. ..	5	6 %	6 %	6 %	..	3⅛— 3⅝	3¼— 3⅝	..	..	..	7 10 11
12,897	Do. do. 4 % Funding Certs.	5	4 %	4 %	2 %	..	2⅜— 3¼	2⅜— 3⅜	..	..	..	5 11 1
134,400	Do. do. 5½ % Loch Leven Debs. ..	100	5½%	5½%	5½%	..	97 —100	97 —100	..	..	..	5 10 0
500,000	British Columbia E. Rail Def. Ord. Stock	100	6 %	8 %	8 %	..	141 —145	142 —146	144½	143½	+1	5 9 7
400,000	Do. Pref. Ord. Stock	100	5 %	5 %	6 %	..	121 —125	121 —125	123½	..	..	4 16 9
400,000	Do. 5 % Cum. Perp. Pref. Stock	100	5 %	5 %	5 %	..	110 —113	110 —113	112½	110½	..	4 8 6
233,000	Do. 4½ % 1st Mort. Debs., 1 to 6,250	40	4½%	4½%	4½%	..	102 —104	102 —104	..	..	..	4 6 7
212,600	Do. 4½ % Vancouver Power Debs., 1 to 2,900	100	4½%	4½%	4½%	..	102 —105	102 —106	..	..	..	4 6 2
433,331	British Electric Traction	10	Nil	Nil	Nil	..	⅜— 1	⅜— 1	1 3/16	..	..	Nil
161,487	Do. do. 6 % Cum. Pref.	10	6 %	8 %	1½%	..	2⅜— 3	2⅜— 3	56/-	..	..	5 0 0
1,475,658	Do. do. 5 % Perp. Deb. Stock ..	Stock	5 %	5 %	5 %	..	84 — 87	84 — 87	86¼	..	..	5 14 11
598,986	Do. do. 4½ % 2nd Deb. Stock Red.	100	4½%	4½%	4½%	..	60 — 65	60 — 65	..	..	..	7 10 0
200,000	British Insulated and Helsby Cables	5	10 %	10 %	10 %	..	7 — 7⅛	7 — 7⅛	7⅛	..	..	6 13 4
100,000	Do. do. 6 % Cum. Pref.	5	6 %	6 %	6 %	..	6½— 6⅝	6½— 6⅝	..	..	..	a 10 7
500,000	Do. do. 4½ % 1st Mort. Deb. Red. ..	100	4½%	4½%	4½%	..	103 —106	101 —104 xd	..	..	..	4 6 7
204,940‡	British Thomson-Houston 4½ % 1st Mort. Debs. ..	100	4½%	4½%	4½%	4½%	89 — 94	89 — 94	..	..	..	4 16 9
400,000	British Westinghouse 6 % Pref., 1 to 200,000 and 275,001 to 75,000	5	Nil	Nil	Nil	..	1/16— 1 1/16	½— ¾	11/-	..	+1/16	Nil
1,016,858	Do. do. 4 % Mort. Deb. Stock ..	100	4 %	4 %	4 %	..	48 — 52	46 — 50 xd	..	..	..	8 0 0
50,000	Browett, Lindley & Co., Ord.	1	Nil	Nil	Nil	..	1/16— 1/8	1/16— 1/8	..	..	..	Nil
50,000	Do. do. 6 % Cum. Pref.	1	Nil	Nil	Nil	..	14/6 to 15/6	14/6 to 15/6	..	..	..	Nil
140,976	Brush Electrical Engineering, Ord., 1 to 105,781 ..	2	Nil	Nil	Nil	..	0 — ⅛	0 — ⅛	..	..	..	Nil
200,000	Do. do. Non-cum. 6 % Pref.	2	Nil	Nil	Nil	..	0 — ⅛	0 — ⅛	..	..	..	Nil
125,000‡	Do. do. 4½ % Perp. Deb. Stock ..	Stock	4½%	4½%	4½%	..	41 — 46	41 — 46	..	..	..	9 15 8
125,000‡	Do. do. 4½ % Perp. 2nd Deb. Stock..	Stock	4½%	4½%	4½%	..	27 — 31	25 — 29 xd	..	..	..	15 3 0
187,610	Calcutta Trams, 1 to 187,610	5	8 %	6 %	4½%	..	4½ — 5	4½ — 5	..	..	..	4 10 0
45,804	Do. 5 % Cum. Pref., Nos. 1 to 29,880..	5	5 %	5 %	5 %	..	4⅜— 5	4⅜— 4⅞ xd	..	..	..	5 2 7
850,000	Do. 4½ % 1st Deb. Stock..	100	4½%	4½%	4½%	5 %	101 —104	99 —102 xd	..	..	..	4 3 8
85,000	Callender's Cable Construction shares	5	15 %	15 %	15 %	..	10 — 10⅜	10 — 10⅜	10½	..	..	6 1s 4
40,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	..	5⅛— 5⅜	5⅛— 5⅜ xd	5½	..	..	4 10 11
300,000	Do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	4½%	4½%	4½%	4⅛%	105 —107	102½ —104½ xd	..	..	..	4 6 2
491,229	Cape E. Trams., 1 to 491,229	1	Nil	Nil	Nil	..	1/16— 1/8	1/16— 1/8	..	..	..	Nil
450,000	Castner-Kellner Alkali, 1 to 450,000	1	8 %	12 %	12½%	..	2¼— 2⅜	2¼— 2⅜	47/3	46/9	..	5 5 3
70,158	Do. do. 4½ % 1st Mort. Deb. Stock	100	4½%	4½%	4 %	..	105 —108	105 —108	..	..	..	3 14 1
1,990 690	Central London Railway, Ord. Stock	Stock	4 %	3 %	3½%	..	64 — 66	67 — 69	69	65½	+3	4 14 2
554,655	Do do. 4 % Pref. Stock	Stock	4 %	4 %	4 %	..	85 — 87	86 — 88	86⅞	..	+1	a 10 11
554,655	Do do. Def. do	Stock	4 %	2 %	2½%	..	46 — 48	48 — 50	50	48⅞	+2	5 0 0
1,480,000	City and South London Railway	Stock	2 %	3½%	1½%	..	32 — 33	33 — 34	33⅜	32 31/32	+1	4 8 3
85,000	Crompton & Co., Nos. 1 to 85,000	5	5 %	5 %	Nil	..	⅛— 1	⅜— ⅝	..	..	— ⅛	Nil
100,000‡	Do. 5 % 1st Mort. Reg. Debs., 1 to 200 of £100, and 201 to 11,000 of £50 Red	..	5 %	5 %	5 %	5 %	90 — 93	88 — 91 xd	..	..	..	5 9 11

* Unless otherwise stated, all shares are fully paid. ‡ From Manchester Share List.

Continued on next page.

SHARE LIST OF ELECTRICAL COMPANIES.—(*Continued.*)

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.—(*Continued*)

Present Issue.	NAME.	Stock or Share.	Dividends for the last four years.				Closing Quotations Dec. 28th.	Closing Quotations Jan. 4th.	Business done week ended Jan. 4th, 1910.		Rise + or Fall —	Present Yield per cent.
		*	1906.	1907.	1908.	1909			Highest	Lowest.		£ s. d.
260,000	Dick, Kerr & Co., 1 to 260,000	1	10 %	10 %	6 %	..	1 — 1⅛	1 — 1⅛	..	..	..	6 0 0
305,000	Do. do. 6 % Cum. Pref., 1 to 305,000	1	6 %	6 %	6 %	..	1⅛ — 1⅜	1⅛ — 1⅜	..	22/-	..	5 4 4
271,080	Do. do. 4½ % Deb. Stock	100	4½%	4½%	4½%	4½%	100 —103	98 —101 xd	..	..	..	4 9 11
60,000	Dublin United Trams. (1896), 6 % Pref., 1 to 60,000	10	6 %	6 %	6 %	..	12⅜— 13⅜	12⅜— 13⅜	..	..	..	4 7 8
99,261	Edison & Swan Utd., "A" shs., £8 pd., 1 to 99,261	5	2½%	2½%	Nil	..	⅜ — ⅜	⅜ — ⅜	..	..	..	Nil
17,139	Do. "A" shares, 01—017,139	5	2½%	2½%	Nil	..	1 — 1⅛	1 — 1⅛	..	..	..	Nil
307,895	Do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	66 — 71	64 — 69 xd	..	..	..	5 15 11
67,720	Do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	5 %	5 %	5 %	..	81 — 84	81 — 84	..	..	..	5 19 1
112,100	Electric Construction, 1 to 112,100	2	Nil	Nil	Nil	..	1/16— 1/8	1/16— 1/8	..	..	..	Nil
81,890	Do. do. 7 % Cum. Pref., 1 to 81,890	2	7 %	7 %	7 %	..	1⅛ — 1⅜	1⅛ — 1⅜	..	..	..	10 4 0
75,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	5 %	..	8 — 8½	7⅞ — 8½ xd	..	..	..	6 1 3
2 0,000	Do. do 4 % Mort Deb.	Stock	4 %	4 %	4 %	..	83 — 87	83 — 87	..	..	..	4 12 0
78,000	Gt. N. & City Rail. Pref. Ord. "A" 4 %, 1 to 78,000	10	4 %	Nil	Nil	..	⅜ — ⅞	⅜ — ⅞	..	..	..	Nil
96,000	Greenwood & Batley, 7 % Cum. Pref.	10	7 %	7 %	..	..	10⅛— 10⅜	10⅛ — 10⅜	..	..	..	6 10 8
80,000	Do. do. 5 % Mort. Debs.	100	5 %	5 %	5 %	..	102 —103½	102 — 103	..	..	— ½	4 17 1
40,000	Henley's (W. T.), Telegraph Works, Ord.	5	5 %	15%	15 %	..	12 — 12⅜	12 — 12⅜	12⅜	..	..	5 17 8
40,000	Do. do. 4½ % Pref.	5	4½%	4½%	4½%	..	5 — 5⅛	5 — 5⅛	..	..	..	4 3 9
150,000	Do. do. 4½ % Mort. Deb. Stock	Stock	4½%	4½%	4½%	..	104 —106	104 —106	..	..	..	4 4 11
50,000	India-Rubber, Gutta-percha & Telegraph Works.	10	0 %	10 %	10 %	..	15 — 15⅜ xd	15 —15⅜ xd	..	..	..	6 7 0
37,500	†Liverpool Overhead Railway, Ord.	10	Nil	½%	Nil	..	⅜ — ½	⅜ — ½	..	..	..	Nil
10,000	† Do. do. Pref., fully paid	10	5 %	5 %	5 %	..	4½ — 5	4½ — 5	..	..	..	10 0 0
600,070	London United Trams. (1901), 1 to 60,007	10	3 %	3 %	Nil	..	1½ — 2⅛	1⅝ — 2⅛	..	..	..	Nil
999,980	Do. do. 60,008 to 100,000	10	3 %	3 %	Nil	..	1⅛ — 2⅛	1⅝ — 2⅛	..	..	..	Nil
125,000	Do. do. 5 % Cum. Pref., 1 to 125,000	10	5 %	5 %	3¾%	..	1⅞ — 2⅛	1⅞ — 2⅛ xd	..	..	..	16 13 4
1,649,930	Do. do. 4 % 1st Mort. Deb. Stock	100	4 %	%	4 %	4 %	59 — 64	57 — 62 xd	59	..	..	6 9 1
6,782,062	Metropolitan Consolidated	100	1 %	½%	½%	..	39⅜ — 40⅛	40 — 40⅛	40⅜	40	+ ⅛	1 4 8
2,640,914	Do. Surplus Lands	100	2½%	2½%	2½%	..	66 — 68	66 — 68	68	66⅔	..	4 0 11
3,285,000	Do. District	100	Nil	Nil	Nil	..	18⅛ — 18⅜	18 — 18⅛	18 1/16	18⅛	— ⅛	Nil
891,337	Metropolitan Electric Trams., Ord.	1	..	..	44%	..	⅛ — ¼	⅛ — ¼	..	..	..	6 10 11
814,016	Do. do. Defd.	1	Nil	Nil	Nil	..	3/16— 5/16	3/16— 5/16	..	..	..	Nil
500,000	Do. do. 5 % Cum. Pref.	1	5 %	5 %	5 %	..	⅛ — ⅜	⅛ — ⅜	..	..	..	6 3 1
595,600	Do. do. 4½ % Deb. Stock Red.	100	4½%	4½%	4½%	4½%	93 — 96	92 — 95 xd	93	..	..	4 14 9
$10,823,200	Mexico Trams Co., Common Stock	..	..	..	..	..	123 —125	126 —128	127	126½	+3	..
$1,000,000	Do. 1st Mort. 50-year 5% Gld. Bds.	..	..	..	5 %	..	91½ — 93¼	91½ — 93½	93	91½	..	5 6 11
245,500	Potteries Electric Traction	1	4 %	4 %	Nil	..	⅛ — ¼	⅛ — ¼	..	..	..	..
245,500	Do. 5 % Cum. Pref.	1	5 %	5 %	5 %	..	⅛ — ¼	⅛ — ¼	..	..	..	6 17 11
245,000	Do. 4½ % Deb. Stock	100	4½%	4½%	4½%	..	84 — 87	84 — 87	..	..	..	5 3 6
37,350	Telegraph Construction and Maintenance	12	15 %	17½%	15 %	..	34½— 36	34½ — 36	..	..	..	5 8 0
140,000	Do. 4 % Deb. Bds., 1 to 1,500 Red., 1909	100	4 %	4 %	4 %	4 %	101 —103	99 —101 xd	..	..	..	3 19 3
1,000,000	Underground Electric Railway, 5% Prior Lien	..	..	..	5 %	..	100 —101	100½ —101½	101¼	101	+ ⅛	4 18 6
2,800,000	Do. do. 4½% Bonds	..	..	..	4½%	..	88 — 90	87 — 89	..	..	—1	5 1 2
4,900,000	Do. do. 6% Income Bonds	..	..	..	..	..	34 — 36	34 — 36	34¾	..	..	..
66,666	Willans & Robinson, 1 to 30,000 & 80,001 to 116,666	1	Nil	10 %	5 %	..	⅛ — ¼	⅛ — ¼	..	..	..	..
66,666	Do. 6 % C.P., 30,001 to 80,000 & 125,001 to 141,666	5	..	6 %	6 %	..	1½ — 2¼	1½ — 2¼	..	..	..	2 8 4
245,495	Do. % 1st Mort. Deb. Stock		4 %	4 %	4 %	..	72 — 77	72 — 77	..	..	..	5 1 3

ELECTRICITY SUPPLY COMPANIES.

15,000	Bromley (Kent) E.L. & P., 1 to 15,000	5	5½%	5½%	5½%	..	4⅛ — 4⅜	4⅛ — 4⅜	..	..	..	5 15 9
70,000	Do. do. 4½ % 1st. deb. stock	100	4½%	4½%	4½%	..	91 — 94	91 — 94	..	..	..	4 18 9
30,449	Brompton & Kens. Elec. Lt. Sup., Ord., 1 to 20,000	5	10%	10 %	10 %	..	7 — 7⅛	7 — 7⅛	..	..	..	6 18 4
9,551	Do. do. 7 % Cum. Pref.	5	7 %	7 %	7 %	..	7 — 7⅛	7 — 7⅛	..	..	..	4 13 4
400,000	Central Electric Supply 4 % Guar. Deb. Stock	100	4 %	4 %	4 %	..	98 —101	99 —102	..	..	+6	3 18 5
80,000	Charing Cross and Strand Electricity Supply	5	5 %	5 %	5 %	..	3⅞ — 4⅛	3⅞ — 4⅛	81/3	..	..	5 14 3
80,000	Do. do. do. 4½ % Cum. Pref.	5	4½%	4½%	4½%	..	4⅛ — 4⅜	4⅛ — 4⅜	..	..	..	4 17 4
80,000	Do. "City Undertaking" 4½ % Cum. Prf.	5	4½%	4½%	4½%	..	3¾ — 4	3¾ — 4	70/-	..	..	5 0 0
445,786	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	98 —101	99 — 99 xd	..	..	..	4 0 10
49,486	Chelsea Electricity Supply, Ord.	5	4½%	4½%	4½%	4½%	3⅛ — 3⅜	3⅛ — 3⅜	..	..	..	6 4 2
175,000	Do. do. 4½ % Deb. Stock Red.	Stock	4½%	4½%	4½%	..	100 —103	99 —101 xd	..	..	..	4 9 1
70,595	City of London Elec. Lighting, Ord. 40,001—110,595	10	6 %	6 %	6 %	..	10½ — 10⅞	10½ — 10⅞	10 1/16	..	..	5 11 8
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	..	11⅞ — 12⅛	11⅞ — 12⅛	..	..	..	4 12 4
400,000	Do. 5% Db. Stk.	Stock	5 %	5 %	5 %	5 %	121 —124	120 —124 xd	..	..	..	4 0 8
800,000	Do. 4½ % 2nd. Db. Stk.	100	4½%	4½%	4½%	4½%	100 —103	98 —101 xd	..	..	..	4 9 1
50,000	County of Durham Electrical Power, Ord.	5	4 %	2 %	..	..	1⅝ — 2	1⅝ — 2	..	..	..	5 0 0
50,000	Do. do. do. 5 % Pref.	5	5 %	5 %	5 %	..	2⅜ — 3⅛	2⅜ — 3⅛	..	..	..	7 8 2
250,000	Do. do. do. 5 % 1st Mtg. Deb.	Stock	..	..	5 %	5 %	93¾ — 95½	91 — 93 xd	91½	..	..	5 7 6
40,000	County of London Electric Lighting, Ord. 1—40,000	10	5 %	5 %	5 %	5 %	7⅜ — 8	7⅞ — 8	..	..	..	6 5 0
55,000	Do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	..	10⅜ — 11⅛	10⅜ — 11⅛	10 1/16	..	..	5 7 10
400,000	Do. do. 4½ % Deb. Stock	Stock	4½%	4½%	4½%	4½%	105 —108	103 —106 xd	105⅜	..	..	4 4 11
400,000	Do. do. 4½ % 2nd. Deb. Stock	Stock	4½%	4½%	4½%	..	98 —101	98 —101	..	..	..	4 9 1
80,000	Edmundson's Electric Corporation, Ord. Shares	5	Nil	Nil	Nil	..	1/16— 3/16	1/16— 3/16	..	..	..	Nil
60,000	Do. do. 6 % Cum. Pref.	5	3 %	Nil	Nil	..	⅛ — ¼	¼ — ⅜	12/6	..	— ⅛	Nil
430,500	Do. do. 4½ % 1st Mort. Deb. Stk.	100	4½%	4½%	4½%	..	57 — 60	57 — 60	..	..	..	7 10 0
$4,150,000	Electrical Dev.Co.of Ontario, 6% 1stMtg.Gold Bnds.	$500	..	..	5 %	5 %	91 — 94	89 — 92 xd	..	..	..	5 8 8
10,000	Folkestone, 1 to 10,000	5	5½%	5½%	5½%	..	4⅜ — 4⅞	4⅜ — 4⅞	..	..	..	5 12 10
10,000	Do. 5 % Cum. Pref., 1 to 10,000	5	5 %	5 %	5 %	..	4⅛ — 5⅜	4⅛ — 5⅜	..	..	..	4 13 0
90,000	Do. 4½ % 1st Deb. Stock	100	4½%	4½%	4½%	..	97 —100	97 —100	100	..	..	4 10 0
15,000	Hove, 1 to 15,000	5	9 %	8½%	8½%	..	6⅞ — 7⅛	6¾ — 7⅛	..	..	..	5 13 4
$1,376,000	Kaministiquia Power Co., 5 % Gold Bnds.	100	..	..	5 %	5 %	101½—103½	100 —102 xd	..	..	..	4 18 0
21,000	Kensington and Knightsbridge Electric Ord.	5	10 %	10 %	8 %	..	7 — 7½	7 — 7⅛	..	..	..	5 4 1
90,000	Do. do. do. 4 % Deben. Stk.	Stock	4 %	4 %	4 %	..	95 — 98	95 — 98	..	..	..	4 1 8
111,000	London Electric Supply Corporation, Limited, Ord.	3	4 %	2½%	3 %	..	1⅞ — 2⅛	1⅞ — 2⅛	35/-	..	..	4 4 3
70,000	Do. do. do. 6 % Pref.	5	6 %	6 %	6 %	..	4⅞ — 5⅛	4⅝ — 5	..	..	— ⅛	6 0 0
882,855	Do. do. 4 % 1st Mort. Deb. Stk. Red.	Stock	4½%	4½%	4 %	4 %	92 — 95	90 — 93 xd	..	..	..	4 6 0
900,000	Metropolitan Electric Supply, 1 to 100,000	5	8 %	6½%	5 %	..	4 — 4⅛	4 — 4⅛	82/6	..	..	5 11 1
76,121	Do. 4½ % Cum. Pref. 1—71,106	5	4½%	4½%	4½%	..	4⅝ — 5	4⅝ — 5 xd	..	..	..	4 10 0
225,000	Do. 4½ % 1st Mort. Deben. Stock	Stock	4½%	4½%	4½%	4½%	106 —109	104 —107 xd	..	..	..	4 4 1
948,000	Do. 3½ % Mort. Deben. Stock Redem.	£100	3½%	3½%	3½%	3½%	83½ — 86½	83 — 86 xd	..	..	..	4 1 5
$1,000,000	Mexican Electric Light Co., 5% 1st Mtg. Gold Bnds	100	5 %	5 %	5 %	..	81 — 83	79 — 81 xd	81⅛	80½	..	6 3 5
$3,585,000	Do. Light and Power Co., Ltd., Common	$100	..	..	3½%	..	68 — 70	68 — 70	70⅛	68½	..	5 0 0
$1,400,000	Do. do. 7% Cum. Pref. Stk.	Stock	..	..	7 %	..	100 —104	100 —104	100⅛	..	..	6 14 7
$12,000,000	Do. do. 5% 1st Mtg.Gold Bnds.	100	..	..	5 %	..	85½ — 87½	86 — 88	89	86⅜	+ ½	5 13 8
950,000	Midland Electric Corporation, 4½ % 1st Mort. Deb.	100	4½%	4½%	4½%	..	98 —100	96 — 98	..	..	—2	4 11 10
130,491	Newcastle-on-Tyne, 1 to 137,500	5	8 %	8 %	2½%	..	3⅜ — 4⅛	3⅜ — 4⅛	..	..	..	2 16 9
137,500	Do. 5 % Pref., 1 to 137,500	5	5 %	5 %	5 %	..	3¾ — 4⅛	3¾ — 4⅛	..	..	..	5 17 8
125,500	North Metropolitan Electric Power Supply Co., 5 % Mortgages (Red.), Nos. 1 to 1,255	100	..	..	..	..	98 — 100	98 —100	..	..	..	..
10,853	Notting Hill Electric Lighting	10	7½%	7½%	7 %	..	12¼ — 13½	12¼ — 13½	..	..	..	5 6 0
20,000	Oxford, 1 to 96 and 407 to 20,310	5	7 %	7 %	..	..	6 — 6⅛	6 — 6⅛	..	..	..	5 7 8
50,000	Do. 4 % Deb. Stock	100	4 %	4 %	4 %	..	95 — 98	95 — 98	..	..	..	4 1 8
119,594	River Plate Elcty. Co. Ord. Nos. 1 to 120,507	1	2½%	6 %	8 %	..	1⅛ — 1⅜	1⅛ — 1⅜	..	..	..	4 18 6
100,000	Do. do. 8% Non Cum. Pref. Nos.1 to 100,000	1	6 %	6 %	6 %	..	1 3/32— 1 5/32	1 3/32— 1 5/32	..	..	..	5 19 0
200,000	Do. do. 5% Deb. Stk. Red.	100	5 %	5 %	5 %	5 %	103 —106	101 —104 xd	..	..	..	4 16 2
40,000	St. James' and Pall Mall Electric Light, Ord.	5	10 %	10 %	10 %	..	8½ — 9	8½ — 9	8⅝	..	..	6 7 0
60,000	Do. do. 7 % Pref. 20,081 to 40,080	5	7 %	7 %	7 %	..	7 — 7⅛	7 — 7⅛	..	..	..	5 11 1
152,000	Do. do. 5½ % Deb. Stock Red.	100	5½%	5½%	5½%	5½%	84 — 88	85 — 87 xd	..	..	..	4 0 6
12,000	Smithfield Markets Electric Supply, Ord.	5	Nil	Nil	Nil	..	1½ — 2	1½ — 2	..	..	..	Nil
85,000	South London Electric Supply, Ord.	4	3 %	4 %	5 %	..	2⅜ — 2⅝	2⅜ — 2⅝	..	..	..	6 9 0
120,000	South Met. Elec. Lt. & Power, Ord.	1	2½%	2½%	2½%	..	1/16— 1/8	1/16— 1/8	..	..	..	4 8 11
142,968	Do. do. 7 % Pref.	1	7 %	7 %	7 %	..	1 1/16— 1 1/8	1 1/16— 1 1/8	22/3	..	..	5 17 11
234,520	Do. do. 4½ % 1st Deb. Stk.	100	4½%	4½%	4½%	..	100 —103	100 —103	..	..	..	4 7 5
80,000	Urban Electric Supply, Ord.	5	5 %	5 %	5 %	..	⅞ — 1	⅞ — 1	..	..	..	25 6 8
50,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	..	1⅛ — 1⅜	1⅛ — 1⅜	..	..	..	14 5 4
275,000	Do. do. 4½ % 1st Mort. Db. Stk. Red.	100	4½%	4½%	4½%	..	74½ — 78½	74½ — 78½	..	..	..	5 14 8
408,000	Victoria Falls Power Co., Pref. Nos. 1 to 408,000	1	..	..	5 %	..	⅝ — 1 1/16	⅝ — ¾	18/6	17/6	..	5 6 8
100,000	Westminster Electric Supply, Ord.	5	12 %	10 %	10 %	..	8⅜ — 9⅛	8⅜ — 9⅛	8⅜	..	..	5 9 7
81,279	Do. do. 4½ % Cum. Pref. Reduced from 5% since 31st Dec., 1905)	5	4½%	4½%	4½%	..	5⅛ — 5⅜	5⅛ — 5⅜	5 1/16	..	..	4 0 0

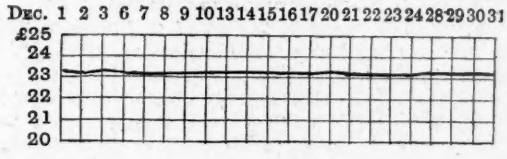
* Unless otherwise stated, all shares are fully paid. † Quotations on Liverpool Stock Exchange.

Bank rate of Discount 4½ per cent., December 9th, 1909

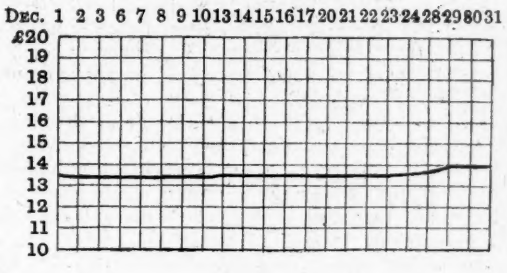
METAL MARKET.

Fluctuations in December.

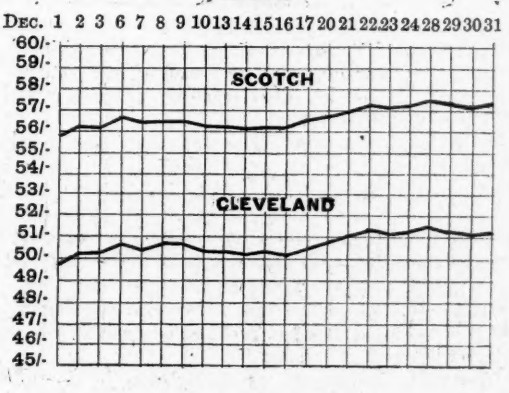
SPELTER (G.O.B's.).



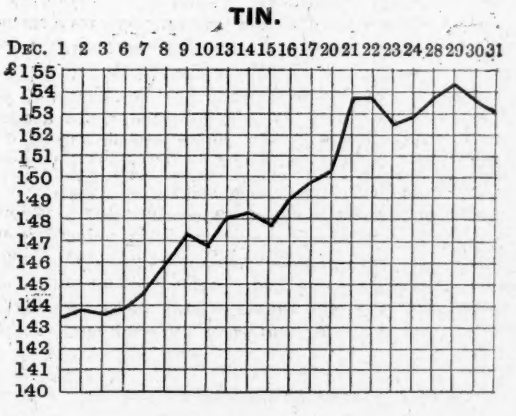
LEAD (ENGLISH).



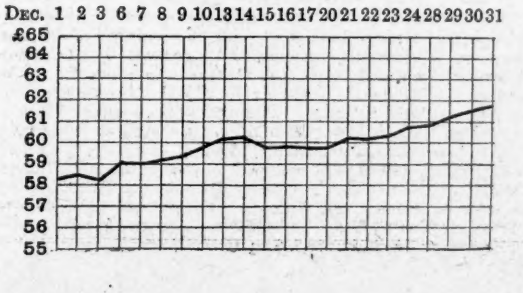
IRON.



TIN.



COPPER (G.M.B's.).



ELECTRICAL WORKS IN PUBLIC THOROUGHFARES.

With the rapid growth of distribution systems in large and populous centres, the electrical engineer finds it necessary to superimpose upon the purely technical aspect of his mains problems, some consideration for the needs of street traffic and the convenience of users of the road—and to work carefully in conjunction with the highways authority, whose occasional objections to his plans are generally formed with the best of intentions, and proceed more from lack of knowledge of electrical requirements and the more conservative traditions of an ancient profession, than any desire to restrict the facilities which the public ways afford for accommodating and tapping the arteries of the electrical system which is becoming so extensive and important in modern communities. Indeed, it seems obvious that the various authorities and persons who make and break the roads, or regulate the traffic upon them, are likely to become quite considerable and appreciative users of the ever-ready source of light and power which lies so conveniently along the course of the modern urban thoroughfare.

Apart from the permanent service of electricity for lighting streets, there arise many occasions when it can be most conveniently employed on public works, for lighting and ventilating sewers and excavations, illuminating the road temporarily by night for urgent street work, and providing power for rail cutting and drilling machines on tramway construction and bridge work. In such undertakings the flexibility of the supply and the handiness of electrically-operated tools render it a most valuable time and labour saver.

The methods and systems of laying electric cable networks are many, and possibly the only uniformity in modern mains work lies in the general excellence with which it is now carried out; experience has taught that with hidden work only the best can ever be cheap, and similar experience has evolved a diversity of methods of laying and protecting cables to suit the varying conditions which obtain in different districts, but in so far as the completed works and their subsequent manipulation are related to the traffic and public use of the roads, there is an encouraging tendency towards standard practice, and considerable evidence that the point of view of the surveyor and police is receiving careful attention.

By laying cables under footpaths, much simpler excavating and reinstatement work is usually secured, and the disturbance consequent upon making new connections is reduced to a minimum, whilst questions of the increasing weight of street traffic do not introduce complications. Where it becomes necessary to take to the road by reason of cellar or pipe obstruction, or in order to effect considerable saving in the length of heavy feeder cables, it is necessary to provide ample protection from heavy engines and road rollers, and box covers need to be massive in design and to be kept in good surface condition to prevent danger of skidding or injury to the wheels of vehicles; even in such cases there is no need to hamper the mains system by restricting the size of boxes unduly, as they can be roofed with girders and concrete so as to be capable of supporting any weight which can conceivably come upon them, and be provided with removable covers only large enough to admit a man's body. The convenience and ultimate economy of ample-sized boxes and draw-in chambers on a big cable system is very great, and in the end is likely to prevent some of the street obstructions which it is the aim of the authorities to avoid. Similarly, pavement covers, if properly made and fitted, may be hardly distinguishable from the surrounding surface, and, if large enough, are less likely to become multiplied in number as the undertaking increases in size, whilst the question of ventilation, which must not be overlooked whilst the gas companies trust to the public to find their leaks, presents no insurmountable difficulties. To a great extent the danger of street box explosions is disappearing, for with the modern system of completely bonding the metallic sheathing of cables, there is less likelihood of any accumulation of gas becoming ignited than formerly. These changed conditions also remove one of the objections which usually exist to draining underground transformer chambers into the sewers; such drainage, if carried out with a suitable siphon for water

sealing the sewer, and a non-return flap to prevent storm water from flooding back into the chamber, would be very useful and save the cost of pumping out the chamber sumps at intervals and the obstruction of the path which this work entails; by suitably arranging the proportions of the collecting sump and the draining siphon, any difficulty due to the water-seal being broken by evaporation could probably be overcome.

Undoubtedly the most important change in electrical street work lies in the use of overground pillars or kiosks for the accommodation of all cable terminals, fuses and transformers. This practice is comparatively recent in this country although it has been fairly general on the Continent for many years, where much of the early work was carried out with overhead wires, and the switchgear and transformers were fixed up on the distribution poles. It would seem that these aerial sub-stations have come down to earth, whilst our own damp and dangerous pits have worked their way to the surface, and their design and construction in each case bears traces of their evolution, the Continental kiosk being generally of an artistic character, and often, excepting in the more considerable cities, a comparatively light structure of sheet-iron, whilst the pillars in our own towns, substantial and roomy as most of them are, often lack any pretension to elegance, and might at small expense be so improved as to greatly reduce the objections now raised to them.

With well-designed transformer or sectionising pillars much of the inconvenience and danger of the old boxes and chambers disappears; manipulation of circuits can be carried out under any conditions of weather with certainty and ease, without exposing insulation to wet or the operator to any undue danger.

The shape and position of the pillars require careful consideration, although the former is to some extent dictated by the contents and capacity; it may be taken, however, that positions sufficiently back from the curb to avoid contact with the hubs of passing wheels, on island refuges or in any small backwater of pedestrian traffic are suitable, if proper attention is given to the space occupied by the doors when opened. In some of the circular forms of pillar the outer case can be revolved, which enables much smaller openings to be used, the apparatus being exposed part by part on turning the case around its axis. Experience also shows the desirability of avoiding any projecting corners or ornaments, unless well rounded, to avoid damage to passers-by or persons crowded against the post; the same remarks apply to the ornamental finials and general form of the top of the pillar —which should preferably not afford a perch for adventurous youth on the occasion of public spectacles—the locks also demand some attention, and should be operated by keys of reasonable size for the pocket, able to withstand rust, and the attacks of the highly diverse implements usually found in a boy's pocket.

It has been urged that these overground chambers constitute a danger in the event of collision by a heavy vehicle; this, however, should not prove a serious risk, as they are usually substantial castings, which on account of their size and depth it is difficult to make less than $\frac{1}{2}$ in. to $\frac{3}{4}$ in. thick, and with a deep and flanged foundation set on concrete they will withstand a heavy shock, and in the event of the case being broken in and coming in contact with live metal, the earth connection should be sufficiently good to open the circuits at once. Needless to say, the earthing of the pillar must be thorough, and if the soil does not provide a sufficiently low resistance connection, spark-gaps or equivalent devices should be used to connect the earthed side of the circuits to the case in the event of the latter becoming alive.

Generally, it may be taken that a great saving in labour and reduction in street obstruction results from the use of pillars; for all ordinary work the road surface is left undisturbed, and the operations of pump men and box cleaners dispensed with.

The lighting of important thoroughfares with arc lamps in place of gas has led to a considerable reduction in the number of posts on the footpath, and where the overhead work of tramway systems is supported by side poles these can also, to some extent, be used for lighting purposes, although, if the utmost use is to be made of the arc lighting it generally becomes necessary to arrange positions with regard to traffic and side streets rather than with a view to uniformity of spacing. Where a clear footpath is of the first importance, both lamps and trolley wires can with advantage be suspended from span wires between opposite buildings, although the trouble of trimming by means of tower ladders, or the provision of elaborate hoisting gear for the lamps introduces disadvantages, and the variable width of thoroughfares and height of buildings makes it difficult to work out a uniform scheme of span wire suspension, in addition to which it is necessary to obtain and generally pay for the right to fix the apparatus to private property.

Similar remarks apply to the use of wall brackets, which, from the point of view of illuminating efficiency, are inferior to centrally-hung lamps owing to the loss of light by absorption on the walls and the obstruction of signs and projections from the building line; they, however, avoid the danger of the heavy moving shadows on the footpath which are thrown from vehicles where centre lighting is in use. Both methods are inferior to the more general arrangement of lamps on the kerb edge placed alternately on each side of the road, which secures a good light on road and footpath with a minimum of shadow. For these reasons the use of poles and posts fixed on public ground is much to be preferred, and in the design of these poles there are several points worthy of attention from the point of view of pedestrian and other traffic. The space occupied by the base should be as small as is consistent with aesthetic demands having in view the character of the thoroughfare and adjacent buildings, and sharp corners and ornamentations encouraging to climbers should be avoided. In most of the earlier designs provision was made for fitting switches, transformers and hoisting winches in the base of the column, but it is now generally possible to arrange apparatus in weather-tight cases at the top of the pole without disfigurement, and to fix the switches where they can be operated with a stick, so avoiding doors in the base, with attendant risk of interference or injury to passers-by by reason of their being left open.

Where lamps are attached to tramway poles it becomes necessary to arrange for all accessories, even the hoisting winch on the outside, and with a little attention to detail this can be carried out quite neatly, which suggests that posts intended for carrying lamps only might be constructed of wrought steel tube with cast-iron bases and ornamentations, resulting in a lighter and more elegant standard, and the elimination of risk of breakage by a colliding vehicle, which occasionally happens to the cast-iron post with results which may be most serious.

The rapid increase of street lighting by incandescent lamps has mostly been effected by the conversion of existing gas standards, and so offers few new problems from the point of view of street work and general appearance, but in extensions, opportunities offer themselves for bringing out the full superiority of electric lighting by dispensing with outer globes, the cleaner and his ladder disappear, the danger of falling glass is overcome, and it becomes possible to use a pole of light and elegant design which may only need attention for lamp changing three or four times in the year.

Attention to these details and a wise liberality in the initial expenditure on new works will result in reduced running costs, better service, and enable electric street works to acquire that permanence and simplicity of operation which has hitherto been the most enviable characteristic of the pipe systems of the gas and water undertakings.—J. W. B.

The Turin Exhibition.—The correspondent of the *Times*, at Berlin, reports that the "Permanent Exhibitions Committee for German Industry," with the approval of the German Imperial Government, has appointed a committee of 115 representatives of trade and industry to make arrangements for the representation of Germany at the International Exhibition which will be held at Turin in 1911. It appears that, whereas German participation in the Turin Exhibition was at first regarded with marked disfavour, the example of other countries, and especially of England, has caused a complete change of attitude. The space reserved for the German section at Turin amounts to 135,000 sq. ft., as compared with 297,000 sq. ft. at Brussels. The site of the British section at Turin, in addition to space reserved for British Colonies, will contain 263,718 sq. ft.

REVIEWS.

Radiation, Light, and Illumination. By Charles Proteus Steinmetz, A.M., Ph.D. Pp. xii—305. New York: McGraw-Hill Book Co. Price $3.00 net.

This book contains a series of thirteen engineering lectures delivered by the author at Union College, and is compiled and edited by Mr. Joseph LeRoy Hayden. The purport of the lectures is sufficiently indicated by the title, and each part of the subject is dealt with in an extremely clear, able, and interesting manner.

We do not know of a subject, so vitally important to all branches of the electrical profession, upon which so much downright ignorance exists, as that of radiation. It has been pointed out in these columns before, that it is difficult in the extreme to find anyone with clear ideas as to what is really the efficiency of radiators. The author sets us on the right track in the opening paragraph, by telling us at once that radiation is a form of energy in itself, which can be turned into heat by causing it to fall upon an opaque body. This disposes of the notion so often met with, that luminous electric heaters waste energy in light.

Dr. Steinmetz proceeds to deal with the corpuscular theory of light, the wave theory, the determination of the velocity, and the light yielded by a body heated to different temperatures. Doubt is expressed as to whether X-rays are waves at all, and the phenomenon of fluorescence is explained as a change of the frequency effected by the fluorescent body. The reasons for the less trying, but possibly harmful, effects of the mercury vapour lamp are clearly set forth, and there is an interesting reference to the distressing results which follow when a light, entirely deficient in the rays which excite the "yellow" or "blue-blind" spot in the retina, is used.

The explanation of black body radiation is clearer than we remember to have seen in other text-books, and in connection with this we may note that a source of error exists in visual pyrometers, which is not mentioned by the manufacturers of such apparatus in their literature. The possible presence of luminescent silicon vapour inside the fireclay tube—of course only at very high temperatures—is likely to interfere with the accuracy of the values obtained.

For the flame test for the presence of an element, the author recommends the use of the nitrate, chlorate, or perchlorate, and this is contrary to what is taught in chemical laboratories as a rule, where the student is told to dip his platinum wire first into a little strong hydrochloric acid. The chloride is thus represented as being the most volatile salt; but at all events for the more refractory substances, the salts mentioned by Dr. Steinmetz are to be preferred.

In dealing with luminescence and disruptive conduction, the author says on page 101:—"A blue glow . . . appears . . . followed by violet streamers (in air the colour being the nitrogen spectrum)." On page 104, however, he says:—"The colour of the nitrogen spectrum is a golden yellow." This is with reference to Geissler tube lighting, which was employed in the courtyard of the Savoy Hotel, and the light there was certainly a golden yellow. The contradiction should receive attention in the event of another edition.

In referring to arc lighting, the author deals with "the erroneous assumption that the positive [carbon] feeds the arc," and proves also that flame arcs are just as efficient with alternating current as with continuous current. He refers to the uselessness of attempting to determine the potential distribution in an arc by means of exploring electrodes, and it is a pity this is not more widely known, for the attempt is still too often made.

Papers on photometry are not infrequent, and the discussions upon them are nearly always profound, even to dullness. Much of the unnecessary verbiage developed might be saved by remembering the following from article 75, pages 167-8:—

"*Light*, however, cannot be measured by any of the preceding methods [*i.e.*, calorimetry, input measurement, or bolometer], since light, in the sense in which it is considered photometrically, is not power, but is the physiological effect of certain wave lengths of radiation, and therefore cannot be measured, physically, as power, but only physiologically, by comparison with other physiological effects of the same nature." And on page 169:—"This is the reason why all attempts to reduce photometry to a strictly physical measurement, and thereby bring photometric up to the high grade of exactness feasible in physical operations, have failed and must necessarily fail; we cannot physically compare an effect as light, which is not a physical quantity, but somewhere in all photometric methods the physiological feature, that is, the judgment of the human eye, must always enter."

We have heard the possibility mooted of using a Crookes radiometer, a selenium cell, or a bolometer, for photometric purposes, but never before have we met with such a clear explanation of the futility of such attempts; time and expense have frequently been wasted, and the futility discovered through the finger ends of the experimenter. Any reader of this book will never attempt anything of the kind in future.

Dr. Steinmetz casts grave doubts on the accuracy of the flicker photometer, and this is not the first occasion on which the correctness of this method has been questioned. For the judgment of relative illuminations there can be no doubt that the luminometer is the one correct way of comparison. The uselessness of the mean hemispherical candle-power as a unit is pointed out, and it is to be hoped that this entirely artificial and meaningless term will now disappear.

Lecture X, headed "Light Flux and Distribution," deals with matters of rather theoretical interest, but the section dealing with diffraction, diffusion, and refraction should be useful. How often frosting is recommended so that light may be diffused, and how few people realise that frosting does not diffuse at all, but diffracts, the light! And how frequently we hear of the desirability of uniformity of illumination and uniform diffusion of light! Dr. Steinmetz points out the dependence of effective illumination upon suitable shadows, and it is interesting to note that in "The Heart of the Antarctic" Sir Ernest Shackleton says that he found the absence of shadows led to frequent unpleasant falls over sastrugi, or ridges formed in the snow by wind, which ridges were invisible because of the uniformity of the diffusion of the light.

The diagrams are well executed, although sometimes not completely lettered; a few misprints exist, as when, on page 123, line 2, we find the word "arcs" where "are" should have been; a split infinitive occurs on page 144; a few Americanisms are to be found, but our objections to these, "aluminum," "mantel" (which is also written "mantle" in the same book), "center," "ultra-red," instead of "infra-red," and some quaint turns of the pen, may be due to insular prejudice. We rather wondered, at first, what "arcing grounds" were, and did not recognise CO, carbon monoxide, under the alias of coal-gas, on page 128. On page 41 we find "a maximum decreasing to infinity," which should clearly be "a minimum increasing thereto," and on page 44 the author's parenthetical correction of himself in writing: "The intensity i of illumination in meter-candles (or rather log. i) as abscissas" (*sic*) looks slipshod.

There is a very complete contents list and a good index; the book is, however, just too large to be slipped into the overcoat pocket, in order that one may occupy in a useful way the time spent in travelling between home and business.

We hope this timely and most interesting book will be read by all who are interested in the progress of electricity, and we cannot make an end better than by quoting the author's concluding sentence: "An enormous amount of work is still to be done mainly in the field of 'engineering physiology,' before the design of a system of illumination can approach the same exactness as for instance the design of long-distance transmission or other engineering work."

Etat Actuel de la Science Electrique. By Devaux-Charbonnel, with a preface by H. Poincare. Paris: Dunod and Pinat. Price 20 fr.

In this work the author reviews the present position of electrical science as regards its phenomena, applications and theories. Commencing with magnetism and electromagnetism, the author proceeds to the thermal phenomena of the electric current, Joule's law, somewhat strangely, coming before Ohm's; chemical phenomena follow, then electromagnetic induction, electric capacity and lastly electro-

statics. Prof. Poincaré, in his preface, points out that this is the order in which the phenomena present themselves to engineers, and which leads up most naturally to the ideas of Maxwell.

In the second part the author deals mainly with telegraphy, being himself a distinguished telegraph engineer, and the section on alternating currents is largely devoted to telephony and wireless telegraphy. This part of the work is mainly original, and contains much that is new and interesting. Most of the third part relates to ions and electrons, and the application of their theory to observed phenomena. While the book is of considerable merit and originality, it by no means covers the subject indicated in the title. It would, no doubt, have been difficult to find an appropriate title which would fit the three practically independent parts, just as it would have been a gigantic task to do full justice to the title actually chosen ; but that is not our concern. The enormous extent of the field of electric science which is *not* dealt with in this work renders its ambitious title very misleading.

Wireless Telegraphy and Telephony. By A. E. Kennelly. Second edition. 1909. London : T. Fisher Unwin. Price 4s.

This is an elementary and non-mathematical treatise suitable for the student. The mode of explanation adopted is largely by pictorial representation and physical conceptions of the electromagnetic and dynamic principles involved. The method is a good one, and is, on the whole, adequately treated, though it is not carried so far as one would expect from Dr. Kennelly. A little amplification in parts appears desirable. In Chapter IV, for instance, when referring to wave propagation between parallel wires, it is not made clear to the student that the total electric flux energy at any point on the conductor is not the same as the total magnetic flux energy, because of the charge associated with, and proportional to, the capacity of the wire at that point. Superposed upon this charge is the pure electromagnetic wave in which both fluxes are equal. The reader is rather left to assume that the total charge (or flux) moves forward simultaneously, and that the whole process constitutes a wave in which the electric and magnetic energies are equal and in phase. This view is, of course, incomplete and wanting in accuracy of conception, as it leaves out the influence of the capacity of the wires.

The spark discharge is referred to on page 44 as the ether giving way. This is an assumption which the student will have to unlearn as his knowledge progresses. It is the molecular arrangement of the dielectric which gives way ; the ether never disrupts.

The diagrams on page 50 and explanations given of the process of "manufacturing and shipping" half an electromagnetic wave are a trifle too laboured to appeal well to the student. In the reviewer's opinion it would be better to treat the phenomenon in a much more general way on the lines of oscillations merging into wave motion from the dynamic point of view ; more especially as the explanation attempted leads to the false assumption that the lines of electric flux glide up and down the antenna with the speed of light. Such an assumption involves phase differences between the top and bottom of the antenna which is incorrect in a pure oscillation. The author would do well to lay stress on the difference between electric oscillations and electric waves, and to indicate on general lines the mergence of one state into the other. Methods of explanation which involve lateral motion of electric flux at the antenna, that is, at the centre of the oscillating source, are fundamentally incorrect. This is not to be taken as implying that the method of representation of wave effects by physical conception is fallacious, but merely that it should be tackled in a more accurate manner. It is a method which would be difficult to replace and an invaluable help if properly handled.

Exception is taken by the reviewer to the remarks regarding "loaded antennæ" appearing on page 123. The author treats the antenna oscillations in the same way as waves traversing a telephone circuit, and fears that lumps of inductance inserted may cause secondary reflections and waste of energy. This fear arises from an inappreciation of the difference between oscillations and waves, and is quite unfounded.

The book contains some very good and useful matter in the way of representing many of the effects concerned, and should prove useful to the student for whom it is intended, and to whom the price will especially appeal.

PROCEEDINGS OF INSTITUTIONS.

Some Quantitative Measurements in connection with Radiotelegraphy.

By Prof. J. A. Fleming, F.R.S.

(*Abstract of paper read before the* Institution of Electrical Engineers, *December 16th*, 1909.)

The principles on which radiotelegraphic apparatus is constructed are now well understood, but the attention of designers and users is being more closely drawn to the consideration of the energy losses in various parts of it, and to the quantitative measurements necessary for a knowledge of the direction in which improvement is possible. The present paper is concerned with the means of making some of the measurements required.

Not only is the resistance of a straight, solid conductor greater for high-frequency oscillations than for continuous currents, but the resistance of a spiral or helix of wire for high-frequency currents is greater than that of the same wire when stretched out straight, because in the first case the current density is greater at the periphery of the wire than at the centre, and in the second case the peripheral distribution is non-uniform, owing to the fact that the external distribution of field is non-uniform, being greater on the interior parts of the solenoid than on the outside.

The following apparatus has been devised by the author for experimentally measuring the ratio of high-frequency resistance R′ to steady current resistance R. Two glass tubes, T, each about 75 cm. long and 3 cm. in diameter, have an expansion at the upper end and a curved bend and expansion at the lower end (see fig. 1). The ends are provided with india-rubber corks perforated by thick

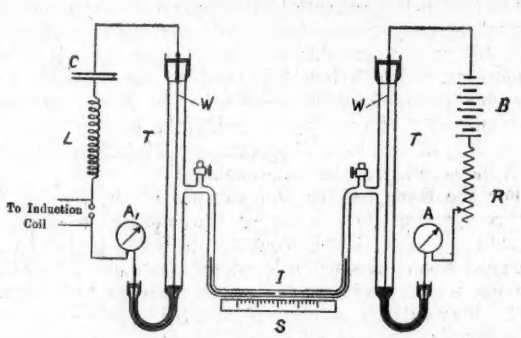


Fig. 1.—Differential Electric Thermometer for High-Frequency Resistance Measurement.

rods of copper, and the lower bends are filled with mercury. The upper corks are also made airtight with mercury or oil. These tubes have side tubes blown on, by means of which they are connected by an inverted siphon of barometer tube, which contains coloured water and an air bubble I in the centre to detect its displacement. This arrangement constitutes a differential air thermometer with two tubular bulbs. In these tubes are placed two identical wires, W, which are fastened to the copper rods passing through the corks at the upper ends and dip into the mercury in the bends at the lower ends. It is convenient to keep these wires in a truly axial position by one or two disks of thin mica. Suppose, then, that we pass the same electric current through these wires in series. Both are heated and heat the air in the tubes, but if everything is symmetrical and the tubes are equally heated the bubble is not displaced. To attain this balance, however, the whole apparatus has to be placed in an enclosure and the position of the bubble observed through a window. If, then, we pass electric oscillations through one wire and a steady current through the other it is possible to adjust the steady current until the heat produced by it in one wire balances the heat produced by oscillations in the other wire. To do this the currents, measured by thermal ammeters A and A_1, have to be passed for some time, so that the thermal condition may become constant. Assuming, however, that this is the case, we have the following state of affairs :—In one wire which has a resistance R we have a steady current, A, producing heat at a rate $A^2 R$. In the other wire of high-frequency resistance R′, we have oscillations of root-mean-square value A_1 producing heat at a rate $A_1^2 R'$. Since the sources of loss are the same in both cases when the final steady thermal state is reached, we have $A^2 R = A_1^2 R'$ or $R'/R = A^2/A_1^2$. The measurement of the root-mean-square value of the currents in both cases is conducted with similar hot-wire thermo-electric ammeters. These are made as described below (see fig. 2).

To eliminate certain causes of error depending upon any inequality in the surface emissivity of the two wires, it is necessary to adopt a process of double weighing similar to that introduced by the author in the case of electric lamp photometry in a paper read before this Institution in 1902, which was found to give good results, and was immediately adopted in the photometric department of the National Physical Laboratory and elsewhere. In this case instead

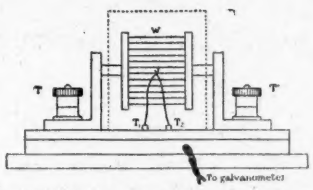


FIG. 2.—THERMOELECTRIC AMMETER FOR LARGE HIGH-FREQUENCY CURRENT MEASUREMENT.

of passing a steady current through one wire and the oscillations through the other, and taking the ratio of the currents when the thermal balance is reached, we first balance the oscillatory current against a steady current and then substitute for the oscillations another steady current and balance again. Or, better still, we may simply reverse the connections and make two observations in which each wire in turn carries the oscillatory and the steady current. It is generally found most convenient to keep the value of the oscillatory current constant and to take the mean of the two readings of the continuous currents. Some precautions are necessary to obtain good results, but it will be seen that the process is a kind of Wheatstone's bridge measurement in which a balance is obtained between two rates of production of heat or two temperatures instead of between two potentials.

The results of observation and the measured values of the ratio R'/R are given in Table I, and against these are set the calculated values in the four cases of single wires obtained by the Russell or Kelvin formulæ.

The same apparatus can be used for investigating the high-frequency resistance of spirals of wire, which is greater than that of the same wire stretched out straight. For this purpose we place in the tubes two similar spirals of wire, and compare the resistance to high frequency to steady currents.

TABLE I.—MEASUREMENTS OF HIGH-FREQUENCY RESISTANCE OF VARIOUS WIRES AND CABLES.

Copper conductor tested.	Frequency = n.	High-frequency current in amperes R.M.S. value = A'.	Mean value of continuous current in amperes to balance A' thermally = A.	Measured ratio of resistances $\frac{R'}{R} = \left(\frac{A}{A'}\right)^2$	Calculated value of ratio of resistances $\frac{R'}{R}$.
No. 14 S.W.G. (d = 0·2 cm.)	470,000	5·37	12·60	5·52	5·64
	440,000	5·95	14 45	5 90	5·47
No. 16 S.W.G. (d = 0·1626 cm.)	450,000	7·09	15 15	4·57	4·54
	460,000	7·89	16 82	4·57	4·58
No. 36 S.W.G. (d = 0·0193 cm.)	540,000	2·81	2 81	1·00	1·005
	736,000	1·94	1 90	0 96	1 010
$\frac{1}{76}$ cable or antenna wire	746,000	6·56	16·73	6·50	—
	444,000	8·10	19 26	5·66	—
Bare copper cable $\frac{7}{0·2}$	439,000	8·08	16 58	4·20	—
	735,000	6 25	15·41	6·10	—
Silk-covered $\frac{12}{36}$, each strand insulated	472,000	8 46	9 93	1·39	—
	472,000	11·00	11 70	1 12	—
Strip 1 82 cm. wide, 0·0147 cm. thick	562,000	7·57	11·28	2·25	—
	445,000	10 60	15·92	2·25	—
Spiral of No. 16 S.W.G., 142·5 turns, length = 5·54 cm. turns per cm. = 2·57	445,000	6·16	14 61	5·62	—
	450,000	5·90	14·20	5 70	—

The results recorded in Table I show that for a frequency of about 450,000, the resistance of the spiral is to that of the same wire stretched out straight in the ratio of 1·25 to 1. Again, the results obtained with the $\frac{12}{36}$ wires show that merely bunching or twisting silk-covered wires as fine as No. 36 S.W.G. is not sufficient to produce a conductor of which the high-frequency resistance is the same as the steady-current resistance.

The conclusion to be drawn from these experiments is that to obtain a conductor the resistance of which to high-frequency currents is the same as its steady-current resistance, it is not only necessary to bunch or twist together fine silk-covered or insulated wires, but the strands must be so arranged that each wire is similarly situated with regard to the others and to external space, and this is not the case when they are stranded as usual. Also experiments show that No. 36 wire is not sufficiently fine for this purpose; No. 40 S.W.G. silk-covered wire should be used.

These experiments have also shown that it is not an easy matter to construct a thermal ammeter which correctly measures the R.M.S. value of large high-frequency currents, for this implies making a conductor for large currents in which the ratio $R'/R = 1$. It is essential that it should not be a shunt instrument. The whole current must, therefore, be carried by fine copper wires well spaced out, and their temperature is best ascertained by a thermoelectric junction made of fine wires, of iron and constantan, or iron and nickel, attached to one of them.

A suitable form of hot-wire ammeter for measuring large high-frequency currents is shown in fig. 2, in which W are a number of bare No. 36 copper wires soldered to end-pieces of brass, which are connected to main terminals T and T. A thermoelectric junction J is attached to the middle wire and is connected to terminals T_1 and T_2, and by leads to a Paul single-pivot galvanometer. Such an ammeter can be calibrated by continuous currents, and will then give the R.M.S. value of a high-frequency current correctly.

The experiments prove that in this differential electric thermometer we have an appliance which affords the means of finding experimentally the ratio R'/R for any wire, and that in those cases in which we can compare the experimental values with those predicted by mathematical theory, the two substantially agree. Hence we have confidence in the results of the measurement in those cases in which the ratio cannot be predetermined by theory. We are, therefore, now in a position to test the portions of any oscillatory circuit for high-frequency resistance, and when we can measure the mean-square value of the current in it by a hot-water ammeter, we can predict the power dissipated in it as heat.

The next matter to which reference may be made is the construction and measurement of standard capacities and inductances. Glass, ebonite and mica are quite unsuitable for making standard high-frequency condensers on account of the variation with frequency of their dielectric constants. Even if air condensers are used for this purpose, there is always some uncertainty whether we are justified in concluding that low-frequency measurements of the capacity of an air condenser give us the correct high-frequency capacity, on account of the spurious augmentation of capacity which is due to glow or brush discharges which occur at high voltages and frequencies.

Hence the author gives preference to condensers made with well desiccated paraffin oil as dielectric, having metal plates immersed in it as follows:—

Two rectangular sheets of stout zinc are bent round formers into square-cornered spirals, the section and appearance of the sheets being then as shown in fig. 3. The turns of the two sheets are intertwined so that the surfaces of one are opposed to those of the other.

These sheets are kept about 1 cm. apart everywhere by four ebonite strips having saw cuts in them, which are fitted on the zinc sheets at top and bottom, and connecting wires are also soldered to both sheets. These sheets are placed in a sheet-zinc box and immersed in high flash-point paraffin oil, which has been treated

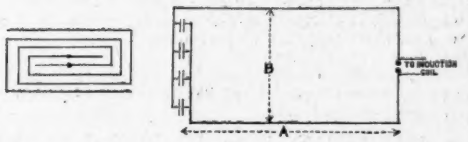


FIG. 3.—PLAN OF HIGH-FREQUENCY CONDENSER.

FIG. 4.—ARRANGEMENT OF CONDENSERS AND RECTANGULAR CIRCUIT TO FORM A STANDARD OSCILLATION CIRCUIT.

for some days with fragments of metallic potassium or sodium to remove all moisture. The sheets must be insulated from the box by ebonite slips. The desiccated oil which forms the dielectric has a dielectric constant of about 2·0, tested at low frequencies, and since its optical index of refraction is close to 1·41, its dielectric constant for optical frequencies must be near 2·0, and hence we may conclude with some confidence that its dielectric constant has also the same value for frequencies of the order of one million or so. The low-frequency capacity may be determined at a frequency of 100 or 200 in the usual manner.

The author has constructed a set of six such condensers, each having a capacity of about 0·0005 microfarad. If the plates are contained in a glass or ebonite box the total capacity is affected by its position with regard to surrounding objects, and the only way to obtain constant capacity is to enclose the plates in an earthed metal box, from which, however, they are insulated by the same dielectric (oil) which separates them from one another.

To determine frequencies and therefore wave-lengths we must associate a known capacity with an inductance, the value of which can be predetermined exactly. No form of inductive circuit is so convenient for this purpose as a rectangle of wire. A wooden frame is constructed having a groove in the edge, and in this groove can be laid insulated copper wire, which is bound in place by silk or string. The wire circuit is cut at the centre of one side and a pair of bullet-shaped spark balls inserted, which slide on the wire. The opposite side is cut to insert the condenser.

The dimensions of the rectangle of wire are then carefully measured. If A is the mean length of one side and B that of the other, and $D = \sqrt{A^2 + B^2}$ is the diagonal and d the diameter of the wire, then the high-frequency inductance L for peripheral distribution of current is given by the formula—

$$L = 9{\cdot}2104\left\{\overline{A+B}\,\log_{10}\frac{4AB}{d} - A\log_{10}\overline{A+D} - B\log_{10}\overline{B+D} - \frac{A+B-D}{1{\cdot}1513}\right\} \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

Thus, if we construct a rectangle 2 metres long and 1 metre wide of No. 14 S.W.G. wire, A = 200, B = 100, D = 224, d = 0·2, and L = 7717 cm. by the formula (8). If such a rectangle is associated with a capacity of 0·001 microfarad it gives us, therefore, an oscillation circuit having an oscillation constant ($\sqrt{C L}$) equal to $\sqrt{7\,717}$ = 2·778 corresponding to a wave-length 195·56 × 2·78 = 543 ft., and if associated with a capacity of 0·006 microfarad it corresponds to a wave-length 2·45 times greater, or 1,330 ft. According'y rectangles of no very cumbersome size, associated with oil condensers of moderate capacity cover the range of frequency most required for wavemeter calibration.

The best method of uniting the rectangular circuit and the oil condensers to form a standard oscillation circuit is as shown in fig. 4. One end of the rectangle is doubled on itself and the condensers inserted as shown in parallel. The discharge path for each condenser is then of the same length, and the mean length A of the rectangle is defined by the line half-way between the closely adjacent double wires or bus wires between which the condensers are placed in parallel.

When, however, we require standard oscillation circuits of lower frequency it is necessary to interpolate in the circuit some more compact form of inductance—such, for instance, as a spiral of one layer or a flat helix of known predeterminable inductance. The use of a spiral involves a small correction, not only for the capacity from turn to turn, but for the change of inductance produced by distribution of current. This last can be annulled to some extent by using fine stranded wire made up of twisted silk-covered No. 40 copper wires. The advantage of using the rectangular inductance is that no capacity correction is required; and if spirals are employed it should be reduced as much as possible, keeping the turns of wire well separated by winding them in a screw groove cut in an ebonite or marble cylinder.

Flat spirals constitute very convenient forms of inductance, and have been already largely used in radiotelegraphy as inductances. Up to the present the author believes no one has pointed out any way in which the inductance of any given flat spiral of insulated wire can be easily predetermined with sufficient accuracy for all practical purposes. The Stefan formula and correction, however, enables us to calculate the inductance of cylindrical and also of flat spiral coils, provided that the breadth and depth are not large compared with the mean radius r.

Very convenient forms of variable inductance without sliding contacts can be made with flat spiral coils—for instance, two such spirals may be mounted on hinged boards so as to come more or less into apposition to each other. The two spirals can be joined up in series by a flexible connection, so that when the boards are shut up like a book the currents in the two spirals oppose each other, and the joint effect is a minimum inductance. When, however, the boards are opened out the inductances of the two coils are added, and the joint inductance is a maximum. We can, therefore, by opening the hinged boards, more or less adjust the inductance in about the ratio of 8 : 1 without altering the total resistance or introducing a rubbing contact.

We can also mount four spirals on two boards pivoted at the centre so as to cross each other, and join up these coils so that when the upper board is turned round through 180° the inductance

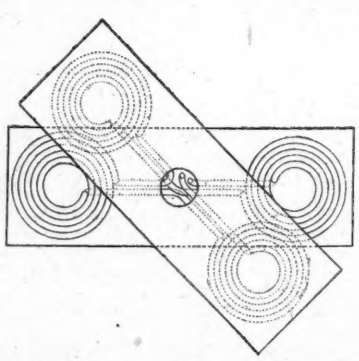


Fig. 5.—Flat Spiral Variable Inductance Coil.

varies from a minimum to a maximum value over a considerable range (see fig. 5). Such arrangements are useful in tuning coils for radiotelegraphic receivers and transmitters.

A pair of flat spirals moving over one another, with planes parallel, has the peculiar characteristic that the mutual inductance can be varied from a maximum value down to absolute zero by quite a small sliding of one coil over the other. Taking advantage of these facts, Mr. Dyke has ingeniously constructed a very compact radiotelegraphic receiving circuit consisting of variable inductance, oscillation transformer of variable coupling and variable condenser, with which he can detect electric waves of any wave-lengths between 300 and 4,000 metres.

Another quantity of great importance for which hitherto no accurate means of measurement has existed is the measurement of spark frequency.

The author has devised a means of recording the spark frequency by photography, by which it is very easy to record up to any frequency obtainable without even approaching the spark to be tested, provided only that an image of it can be thrown by means of a lens upon a pinhole.

This improved photographic spark counter is constructed in the following manner:—A well-made wooden box, perfectly light-tight, and blackened in the interior, with a door on one side, is furnished with a good rapid rectilinear camera lens L at one side (see fig. 6). The lens tube has the usual iris diaphragm. The box is 38 cm. high, 38 cm. wide, and 25 cm. broad. The lens tube is prolonged

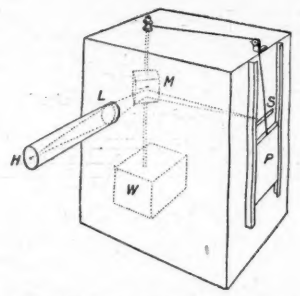


Fig. 6.—Photographic Spark Counter (Fleming).

by another tube closed at the end, but with a very small hole H in the cover. In the interior of the box is a train of clockwork, W, which drives round a vertical shaft about 18 times per minute. This shaft carries a cubical block of aluminium to the four sides of which are affixed carefully flatted glass plates silvered on the surface. This cubical mirror M is so placed that it receives a ray passing through the small hole in the collimator tube and gathered by the lens and reflects it at right angles, or nearly so, so that the ray falls on a slit S in the side of the box about 1 cm. wide and 7 or 8 cm. in length. Outside the box a plate carrier P slides down in grooves in such fashion that when the slide is drawn out the exposed sensitive plate glides past the slit in the box. The same clockwork that drives round the cubical mirror lowers the photographic plate at a uniform rate so that it travels over the slit. If, then, the pin-hole in the end of the collimator is illuminated intermittently by the image of a spark thrown on it, the ray passing through the lens and reflected from a revolving mirror is brought to a focus on the photographic plate, and sweeps across it, imprinting an image on the plate at intervals depending on the frequency of the spark.

Four times in each revolution of the cubical mirror block a train of images sweeps over the gradually falling photographic plate, and when this is developed we find it covered with rows of black spots, each of which denotes the occurrence of a spark. It is clear that the number of sparks per second bears a definite relation to the speed of the revolution of the mirror and to the angle subtended by the slit at the mirror, and to the speed at which the photographic plate is lowered past the slit in the camera.

When such a spark counter is used to photograph the oscillatory spark at the spark balls of a radiotelegraphic transmitter, we find that the results are extraordinarily different, according to the nature of the potential generator used, whether induction coil or transformer; also depending on the nature of the interrupter if a coil is used, and especially upon the length of the spark-gap, and whether it has an air blast applied to or not.

For short spark-gaps the effects taking place are complicated by a number of factors. Although the frequency of the transformer remains constant, the time interval between each spark is not by any means constant, because the exact voltage at which discharge takes place depends upon the state of ionisation of the air-gap left after the previous discharge. Accordingly this spark counter shows us the futility of all plans for effecting resonance between two stations depending upon syntonisation of the spark frequency and not the oscillation frequency.

The same effect is seen in a more marked manner when photographing the spark of an ordinary induction coil working with a hammer or mercury break. In the case of the hammer break the time interval between the sparks is extremely irregular, showing that there is no kind of isochronism in the spark frequency.

Some very interesting photographs have also been taken with this apparatus of the discharge produced by a quenched spark or Wien discharger of the type now used by the *Gesellschaft für drahtlose Telegraphie*. This discharger consists of a number of copper disks with interposed mica rings, the surface of the copper disks being made extremely true and separated by a fraction of a millimetre. A series of 10 or 12 of these disks are piled one on the top of the other, producing a compound spark-gap consisting of very short intervals. These short spark-gaps, as is well known, possess large damping power, and the discharge therefore consists of a series of very rapid discharges. As it is not possible to see the spark discharge in the interior of this arrangement, a supplementary naked, very short spark-gap is joined in series with it, consisting of two brass points separated by a very short interval, so that visible sparks happen at this external spark gap corresponding to each of the spark discharges in the interior of the copper disk discharger.

Although this discharger does not give undamped oscillations it gives closely adjacent trains of oscillations, having therefore a relatively large mean square value.

It will be seen, therefore, that it is of great importance to apply a photographic spark counter of the type described to examine the nature of the discharge in all cases of spark telegraphy, and also in those cases in which any measurements are made of decrement or spark resistance where the length of the spark-gap may be varied

between two experiments. It is quite fallacious to conclude that the number of discharges which take place between the spark balls of such a discharger when operated by means of a transformer or induction coil with mechanical break, can be deduced from the frequency of the alternator or from the speed of the break. The number of discharges which actually take place across the spark-gap may bear no definite relation at all to either the speed of the alternator or the speed of the interrupter.

Two other important measurements peculiar to radiotelegraphy are the wave-length and damping or logarithmic decrement of the oscillations.

The wave-length is measured by bringing into loose coupling with the antenna some other circuit having inductance and capacity, one or both of these elements being variable, and ascertaining what adjustment of these must be made to make the current in this secondary circuit a maximum. This can be done with the author's cymometer or other wavemeter, which can also be employed to measure the decrement of the oscillations either in the sending or receiving antenna.

The power of making the above-described measurements renders it possible to obtain an estimate of the overall efficiency of a radiotelegraphic transmitter. By this term we mean the ratio of the mean power in watts emitted by the antenna in the form of long electric waves useful for radiotelegraphic purposes to the mean power given to the transformer or induction coil.

The following figures give the experimentally determined values of the various constants and quantities for an inductively coupled spark transmitter in the Pender Electrical Laboratory of University College, London, for one particular adjustment and spark-gap. The plant consists of a rotary transformer by Crompton taking continuous current from a storage battery of 220 volts, and giving alternating current of a frequency of 100 at 150 volts. This is transformed up by an oil-insulated transformer to 15,000 or 20,000 volts, a pair of chokers or throttling inductances being interposed to stop arcing. The transformer charges a glass-plate condenser in oil, and this discharges through the primary of an oscillation transformer, the secondary of which is inserted in the antenna circuit. The spark-gap is 5 mm., and the sparks were counted with the photographic spark counter. The high-frequency resistances of the circuits of the oscillation transformer and of the antenna were determined experimentally. The antenna consits of four $\frac{1}{16}$ copper wires, each about 60 ft. vertical and 90 ft. horizontal, and the length of secondary jigger wire (No. $\frac{1}{32}$) with connections, is 45 ft.—in all very nearly 195 ft. These wires are spaced 8 or 10 ft. apart. A resonance curve was taken with a cymometer, and the resistance decrement of the primary oscillation circuit determined and also the radiated wave-length (1,350 ft.), and the values are as follows:—

Spark frequency = 208.
Capacity of condenser = 0·0139 microfarad.
Spark voltage = 17,500 volts.
Oscillation constant = 6·9.
Current in condenser circuit, R.M.S. value = 26·5 amperes.
Mean wave-length = 1,350 ft.
Decrement of condenser circuit = 0·0507.
Antenna current, R.M.S. value = 4·9 amperes.
High-frequency resistance of antenna circuit, 0·528 ohm for jigger secondary circuit, 0·21 ohm for antenna proper.
Length of whole antenna = 195 ft., 4 branches.
Power given to rotary transformer in watts = 2,620 watts.
Power in watts radiated from antenna = 78.

The efficiencies of the various portions of the apparatus were measured, and are set out below.

There is a large loss in the chokers and rotary, due to these appliances not being properly designed for a low power factor. Hence the overall efficiency is very low, but the efficiency from transformer to antenna is about 10 per cent. The efficiency will unquestionably vary with the spark length, and there is still a wide field of research to be covered in investigating the efficiencies corresponding to various conditions.

It is clear that there is considerable room for improvement in efficiencies, and now that we have the means of testing the efficiency of each stage of the energy transformations, we can put our finger on the sources of energy dissipation with a view to their removal.

TABLE OF EFFICIENCIES.

Rotary efficiency = 57 per cent.
Choker efficiency = 57 per cent.
Transformer efficiency = 56 per cent.
Oscillation generator efficiency = 21 per cent.
Antenna efficiency = 83 per cent.
Efficiency from transformer intake to radiation = 10 per cent.

Greater care should be taken in the construction of primary oscillation transformers in the condenser circuit, to avoid unnecessary resistance losses. The mere twisting together of bare wires or use of ordinary stranded cable, or even cables made of fine insulated wire, unless properly stranded, is not enough. The circuits should be made of fine insulated wire, single cotton covered, plaited in flat form, so that each wire is equally exposed. The chief source of the damping is undoubtedly in the spark itself. There is a wide field open for research in connection with various forms of spark discharges to ascertain which form conveys to the antenna the largest fraction of the power given out by the charging transformer. Until this is done we cannot say in what direction improvement is possible.

We are concerned in the next place with the efficiency of reception or the determination of the fraction of the radiated power which is captured by the receiving antenna.

The current in the receiving antenna is generally very small, but if it is large enough to be measured by a bolometer or any form of hot-wire ammeter such as the Duddell micro-ammeter with a heater of known resistance, then its mean-square value can be found and the power absorbed by the receiving antenna measured.

We can from the known high-frequency resistance of the antenna and of the heater wire of the ammeter, calculate the total power captured by it. We have, then, the means of determining the ratio of power expended in signalling to the power expended in making the signal.

In a certain case of a plain antenna 50 metres high and 4 mm. in diameter on board the French battleship *Henri IV*, corresponding with a similar antenna at a distance of 1·7 kilometres, M. Tissot showed that, when the antenna was charged 20 times per second with a voltage equal to a 5-cm. spark, the mean radiation was 36 watts, or $1{\cdot}8 \times 10^7$ ergs per spark. At a distance of 1 kilometre the energy picked up by the similar receiving antenna was 320 ergs per spark or 6,400 ergs per second.

The captured energy was only about $\frac{1}{600}$ of 1 per cent. of that sent out, and since this latter was at most 5 per cent. or 10 per cent. or so of that given to the transmitter from the external source (battery or alternator), it is seen that the entire resultant efficiency was extremely small.

In radiotelegraphic stations the standby costs are so vastly greater than the cost of power actually used in signalling, that even a large improvement in the efficiency of transmission would not greatly reduce the total costs; radiotelegraphic engineers have therefore quite rightly directed attention first to securing what may be called efficiency of operation—viz., certainty and speed in sending and receiving messages as well as in gaining freedom from interference—before dealing with questions of energy efficiency. Nevertheless these last must be considered in turn, and the means of making exact quantitative measurements in connection with the subject is a matter of the greatest importance for its further development.

Efficiency of Short-spark Methods of Generating Electrical Oscillations.

By W. H. ECCLES, D.Sc., and A. J. MAKOWER, A.M.I.E.E.

(*Abstract of Paper read before the* INSTITUTION of ELECTRICAL ENGINEERS, *London, December 16th*, 1909.)

THE authors trace the evolution of the short gap and low-voltage system of generating electrical oscillations, and describe experiments carried out with a discharger of the Lepel type with a view to determining the efficiency of this method which involves the use of an extremely short air-gap between plane copper surfaces, which are thoroughly cooled with circulating water so as to quench the discharge quickly. The discharge surfaces in the experiments were separated only by one or two thicknesses of foreign note paper.

For the purposes of wireless signalling, the discharger is connected, as shown in fig. 1, in which I I represent choking coils, R R regulating resistances, and S the main switch in the supply leads. The primary oscillating circuit is formed by the inductance L and the capacity C, and the secondary circuit by the aerial conductor whose capacity to earth is K, the inductances N and L, and the condenser C. The last-named path must be tuned by trial to the oscillating circuit L G C. The secondary is associated with the primary first by the direct or conductive coupling at G, and, secondly, by the mutual inductance coupling between N and L. The two couplings must be connected so as to conspire.

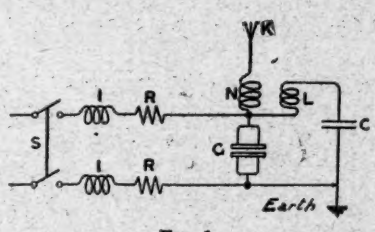


FIG. 1.

Only a fraction of the total energy taken from the supply circuit is received at the gap terminals, and only a fraction of this again will be received into the secondary circuit or aerial. Of this last portion some will be wasted ohmically, but most will be radiated.

The overall efficiency of the process is obtained by dividing the energy radiated, by the energy taken from the direct-current mains. This figure has in the best case a very low value, owing to the large proportion of the total energy that has to be wasted in the ballast resistance R. Another figure for the efficiency, which is often given, takes no account of the losses in the resistance and is obtained by dividing the energy radiated by the energy supplied at the gap terminals, and thus includes among the losses only the heat generated at the gap and in the oscillatory circuits.

As there is no direct way of measuring the energy radiated from an aerial wire, the authors used a special resistance instead of an aerial for dissipating the energy. The capacity of the aerial was replaced by an air condenser of capacity about the same order as that of an actual aerial. Calorimeters enabled the energy passed on to the secondary circuit as electrical oscillations and the heat wasted in the ballast resistance to be measured simultaneously.

For determining the heat wasted in the arc advantage was taken of the cooling system. The supply voltage was 500 volts. The frequency of the oscillations was 294,000 cycles a second, and therefore the wave-length was 1,020 metres.

The results of some of the experiments are set out in the table:—

Short-circuit current.	Current during run.	η	η'
1·46	0·7 to 0·9	0·489	0·144
2·10	1·4	0·406	0·055
4·70	3·4	0·357	0·046
6·75	—	0·186	0·012

The short-circuit currents shown above were the currents that were found to flow when the line voltage was applied to the circuit with the gap shorted.

η represents the efficiency, exclusive of the losses in the ballast resistance; η', the efficiency, including these losses.

The highest overall efficiency recorded above is 14·4 per cent.; and this was the highest efficiency reached in all the experiments. The values for the overall efficiency became lower the greater the current.

In actual practice, when the oscillations are being used for wireless signalling, the discharge is broken up into dots and dashes, and so the heating of the electrodes may be so much less than in the authors' continuous runs that somewhat higher values of the efficiency may be obtained momentarily.

It has been stated that overall efficiencies of 60 per cent. have been obtained, but the above measurements cast some doubt on the rough estimates published hitherto.

The two papers were discussed together.

MR. J. E. TAYLOR said that as regarded the measurement of high-frequency resistance of conductor, Prof. Fleming had not said what percentage of accuracy was attainable; presumably it was not great. He felt disappointed in the table given, which brought out the inconsistency of the measurements and calculated values. He was afraid, judging from this, that the method of checking losses throughout was not a very accurate one, and he was rather inclined to doubt the figure of 78 watts mentioned as the power radiated at the University College installation. One reason for doubting was because the high-frequency resistance of the antenna, given in the paper, left out the loss in the earth connection, which was combined with the antenna. Wherever an earth connection was made there were considerable losses where the current entered the soil; there was also loss due to electrostatic conductors near and to electromagnetic induction. He thought the actual balance available for radiation was less than shown.

PROF. ERNEST WILSON said the question of energy efficiency was important to the P.O. authorities, as it enabled them to obtain some idea of the energy and possibilities of systems which they licensed. He thought that possibly eddy currents in the wires of the antenna might vary the dissipation of energy by the different wires, and as Prof. Fleming had measured only one wire, this might affect his result. Similar effects could also obtain in the condenser plates.

PROF. J. T. MORRIS asked if Dr. Eccles and Mr. Makower had measured the variation of efficiency with length of spark or experimented on the medium of the gap. Coal gas and amyl-acetate produced sudden jumps in voltage, as the frequency changed, which were not present in air. He had found that with paraffin oil in the spark gap of the oscillator, he got 13 times as much energy in the receiver as with air, and it was the same with amyl-acetate. The test results were obtained with gaps of $\frac{1}{100}$ mm. for paraffin oil, $\frac{1}{100}$ mm. for amyl-acetate and 400 mm. for air—the experiments being carried out with a frequency of 50.

DR. ERSKINE MURRAY questioned the accuracy of Dr. Fleming's differential thermometer for resistance measurements; an error would be introduced in the coupling up of the induction coil, which, however, would be cancelled by his neglecting the higher resistance of damped waves. He thought the cinematograph would be preferable to Dr. Fleming's spark camera. The experiments of Dr. Eccles and Mr. Makower gave a better method than the spark method of calculating efficiency, although it was better with direct-current to use one electrode of copper, and another of brass, rather than both of copper; also the Eureka wire resistance, with low temperature coefficient, was the worst they could have used.

PROF. FLEMING having agreed to reply in writing to the various points raised, DR. ECCLES mentioned that they had chosen the best spark gap for their purpose by inserting paper between the electrodes, and he thought the burning paper produced a higher efficiency. The diagram of connections in the paper did not represent what was actually used. A hard brass electrode had been tried, but without appreciably altering the results obtained.

On the Use of the Flicker Photometer for Differently Coloured Lights.

By H. MORRIS-AIREY, M.Sc., F.R.A.S.

(*Abstract of paper read before the* INSTITUTION OF ELECTRICAL ENGINEERS, *Newcastle, December 13th*, 1909.)

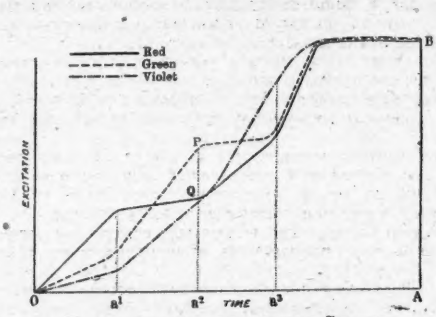
FROM time to time suspicions have been raised as to whether the principle on which the flicker photometers are based does not involve physiological phenomena which disturb the conditions of illumination, so that the numbers obtained are not a true representation of the illuminating powers of the sources to be compared. The exact *rôle* which the speed of rotation of the flicker head plays in the experiment is especially doubtful, while physiological evidence indicates that the effect is a very complicated one, and the simple theory of the flicker effect is not tenable.

The problem as to what actually happens in the retina when it is stimulated by steady or intermittent light is, of course, a physiological one, and in seeking for some generally accepted facts with regard to colour vision, we are met with the difficulty that the most eminent physiologists are hopelessly at variance.

With every new theory of colour vision the physicist would have to change his starting-point in the explanation of phenomena like the flicker effect, and I suggest that a more stable foundation for a physical theory is to be found in the experimental examination of the growth and decay of the retinal stimulus due to differently coloured lights, without any attempt to connect the form of the curves obtained with physiological theories which are admittedly of uncertain stability.

The work of G. N. Stewart (*Proceedings* Royal Society, Edinburgh, 1888) appears to afford us the necessary data.

In reference to Talbot's law of the fusion of intermittent light stimuli, Stewart found that on observing the flashes of light reflected from a rotating mirror placed in a darkened room, a series



EXCITATION DUE TO VARIOUS STIMULI.

of colour changes in the appearance of the image of the source took place as the speed of the mirror was altered. These changes take place at or under the speed necessary for the complete steady fusion of the flashes.

The results are shown in the figure above.

The three curves represent the growth of the stimulus for red, green, and violet light. The time during which the light acts is measured horizontally, whilst the intensity of the excitation is given by the ordinates of the respective curves.

For a white light stimulus of long duration O A, the excitation of all three colours is equal, giving the sensation of white light. For stimuli of shorter duration, O a_3, O a_2, O a_1, the violet, green, and red excitations are predominant. The succession of colours in "after-images" as described by Helmholtz, Fechner, and others, is consistent with the assumption that the decay of the excitation follows a similar set of curves.

When the light stimulus consists of a series of short illuminations, we may therefore have different predominant tints according to the length of the stimulus and its frequency.

As these colours are observed with intermittent light when the frequency is about or under that required for complete fusion (*i.e.*, disappearance of the flicker), it seems difficult to avoid the conclusion that they will play an important part in the appearance of a flicker photometer head when using it for comparing different colours.

Suppose we have adjusted the sources and speed of rotation so that the flicker has just disappeared and we have a balance. The flashes from either source considered independently evidently occur at a rate such that the excitation is not fully developed. If, for example, we were comparing a red and a green source and the duration of each illumination corresponded to O a_2, the effects *actually* being compared would be a red light of intensity $\frac{Q\,a_2}{A\,B}$ times the real intensity, and a green light whose intensity had been reduced by the ratio $\frac{P\,a_2}{A\,B}$, and though the appearance seen by the eye might be a steady illumination whose colour was that produced by mixing red and green light together, this can hardly be interpreted to mean that the actual brightness of illuminations at the flicker head has been adjusted to be the same.

If the speed of the flicker head is altered, we shift the position of the ordinate we are considering, and shall then have to readjust the positions of the sources to regain the balance.

The same thing will apply when the sources are not pure red and pure green, but differently tinted lights, such as a carbon-filament and a metal-filament lamp, and this in practice leads to the results observed by Lauriol, Wild, and others.

Whatever may be the ultimate physiological explanation of the working of the flicker, I think the above discussion shows that the conditions under which the retina is excited during a measurement with the flicker type of photometer are not the practical conditions of illumination to which it is our object to apply the data we obtain from the experiment.

The discussion was somewhat restricted, as comparatively few of the members were directly interested in the subject; but several of the experiments helped towards a clearer understanding of the

paper, and all were followed with the closest attention. The demonstration concluded with experiments showing the effects mentioned in G. N. Stewart's paper (*Proceedings* Royal Society, Edinburgh, 1888), the Benham top and the Simmance and Abady flicker photometer.

Prof. Stroud agreed that unless the lights were of the same kind the results given by the flicker photometer would be approximately correct only.

Dr. Thornton, in referring to the time effect of stimulus on the eye, said that the chief claim of the flicker photometer, in commercial work, was for sensitiveness rather than accuracy. It was an exceedingly difficult matter to compare, say, an arc lamp with any of the smaller sources of illumination, especially those of a yellow colour. In the case of metal-filament lamps, although these might appear perfectly balanced to the eye, a decided want of balance could be shown by photometry.

Mr. J. H. Holmes asked for further information as to how long it took the normal eye to receive the full stimulus from a ray of light, and he further urged the importance of being able to accurately photometer sources of light such as flame arc lamps.

Mr. Morris-Airey briefly replied to the various points raised in the discussion, and agreed that it was questionable whether it was scientifically possible to talk of comparing the relative intensities of differently coloured lights.

CONTRACTOR OR MANUFACTURER?

[COMMUNICATED.]

So much has been written and said of recent years as to the relation between supply stations, contractors, and manufacturers, that any further comments on the situation may be deemed superfluous. But in the opinion of the writer, a few notes on the subject from the point of view of the manufacturer may be interesting, and may incidentally throw some light on the position of the various interests from a somewhat different standpoint to that usually taken.

Some good may also be done by the following criticisms in bringing home to the established contracting firms the need of more effectually pushing the varied applications of electricity among the public.

Before discussing the subject in its various aspects, it may be generally conceded that the principal grievances of contractors at the present day may be stated as follows :—

1. The competition of supply station wiring departments (municipal and other) on the one side, and on the other—

2. That of ironmongers, plumbers, unattached wiremen, and other free lances.

3. The fact that the public in these days are getting more into touch direct with manufacturers to the exclusion of the contractor or middleman.

Now the writer's remarks are not intended to cover the whole subject, even were this possible in a short article. The much discussed question of whether or not supply authorities should undertake installation work may be passed over with the remark that the supply stations' stake in the district covered by their mains, is very much greater and more permanent than that of the local contractors (who often are here to-day and gone to-morrow). If the contractors in a particular district are not making the most of their opportunities, the supply authority can hardly be blamed if it take the matter into its own hands. In this connection does anyone seriously suggest that contractors generally have really pushed the power business, or the adoption of electric heating devices, or the use of electric ventilating appliances, signs, &c.? And when they have actually installed such apparatus, has it not been largely due to the seed having been sown in the first instance by the manufacturers or by the supply station engineers?

If one excludes the established and prominent contractors (whose sphere after all more especially covers the electrical installations in large public buildings, Government contracts, and country house and private plants) the smaller firms are hardly in a position, either technically or financially, to properly exploit the electrical possibilities of any particular area. This is another reason, therefore, why supply engineers are finding it increasingly necessary to take up the cudgels in self-defence.

This article, however, being written in order to point out the present position of the manufacturer in this matter, it may be explained that the supply stations nowadays find in the larger manufacturers very important allies, more particularly in the power business.

The greater proportion of the enormous development of this business of recent years is to be traced entirely to the combined and mutual operations of the stations and the manufacturers, and very little to contractors themselves, who are, moreover, not fitted, for the reasons previously given, to handle it.

Again, it is really only to be expected that the proprietor of a large factory, about to install electric power, would approach manufacturers direct and entrust the whole of the work to the selected firm. The same thing is happening in other trades, and the vast majority of the suction-gas plant, gas and steam engines, are sold and erected direct by the makers, and not by a middleman. Moreover, from the makers' point of view, it is to be preferred, a higher price being obtained, together with prompt settlement and less financial risk, as a rule.

This is intended to be an outspoken survey of facts as they are to-day, and it can hardly be denied that the financial position of 75 per cent. of the contractors is unsound, or that they fail to support English manufacturers of the front rank.

It is not intended to convey the impression that manufacturers desire to undertake wiring work, or to compete for electric lighting work; in fact, almost without exception, where this is, perforce, undertaken, it is sub-let to a contractor conversant with the methods of the particular firm.

Much nowadays is written as to the future of the contracting industry. In the opinion of the writer there are not bright prospects ahead. Supply station showrooms and contracting departments, are likely to increase, while as regards the power and heating business, this will be almost entirely done direct with the public, by either the manufacturer or the supply stations or by both.

The smaller work will still remain in the hands of free lance contractors, all seeking to get work by further cutting of prices, while the established firms of repute will have no difficulty in retaining in their hands the country house work and that connected with public institutions, &c.

Contractors in the past have gone through many vicissitudes, largely due to their own policy and lack of enterprise. These remarks from a fresh point of view may serve to show that something more than a Contractors' Association is required if the position is to be bettered. They are indispensable neither to the manufacturer nor to the supply authority to-day, whatever they may have been in the past.

In conclusion, it may be interesting to recall Mr. Alexander Siemens's remark that "nowadays contractors seemed to spend their lives in going into and out of partnership and notifying the trade to that effect."

FOREIGN AND COLONIAL TARIFFS ON ELECTRICAL GOODS.

Amendments.

BRITISH HONDURAS.—An ordinance, assented to on October 28th, removes from the list of articles accorded free entry into British Honduras, certain specified fittings for electric lighting—viz., shades, electroliers, standards and pendants.

HAITI.—The Board of Trade have received through the Foreign Office a copy of a Haitian law imposing from the 23rd August last a surtax of 15 per cent. over and above the aggregate import duties in order to provide funds for paying off a loan which the law authorises the Haitian Government to contract. When the loan is paid off the surtax is to be reduced to 10 per cent., the proceeds being applied to the withdrawal of nickel coinage at present in circulation. The rates given in the statement of import duties, published in the Electrical Review of November 12th, 1909, will consequently have to be increased by 15 per cent. to arrive at the amount of duty actually payable.

HOLLAND.—A recent decision of the Dutch Customs authorities provides for the free importation of transformers, consisting of a motor and a dynamo mounted on a joint ground plate and coupled together.

SERVIA.—The following reductions have been made in the duties leviable in Servia on goods imported from the United Kingdom; the new duties came into force on November 17th:—

	Previous rate. Dinars per 100 kg.	New rate. Dinars per 100 kg.
Tissues of caoutchouc, or of stuffs saturated or covered with caoutchouc or gutta-percha for technical purposes	60	36
Articles of asbestos:		
(1) Paper and cardboard made of asbestos, polished, cut, pierced, also with inserted wire	30	18
(2) Spun wares of asbestos, also braid, string or cord, even combined with other woven materials or wire ...	30	18
(3) Tissues made of asbestos, even combined with other textile materials, and having the weft and warp of wire of common metals or their alloys ...	40	24
(4) Other articles of asbestos, asbestos paper or asbestos tissues, gloves, clothes, masks, caps, hose, shoes, even combined with other common materials	60	36

NEW PATENTS APPLIED FOR, 1909.

(NOT YET PUBLISHED.)

Compiled expressly for this journal by MESSRS. W. P. THOMPSON & Co., Electrical Patent Agents, 285, High Holborn, London, W.C., and at Liverpool and Bradford, to whom all inquiries should be addressed.

29,706. "New or improved method of regenerating storage batteries." C. LUCKOW. December 20th. (Complete.)

29,719. "Improvements in magnetic compasses." KELVIN & J. WHITE, LTD., L. W. P. SHETWYND and F. W. CLARK. (Date applied for under Rule 13, August 19th, 1909. An invention comprised in Application No. 19,057, dated August 19th, 1909.) December 20th. (Complete.)

29,773. "Improvements in means for preventing corrosion of electrical terminals." H. A. W. MIDDLEDITCH. December 20th.

29,785. "Improvements relating to controllers for electric motors." BRITISH THOMSON-HOUSTON CO., LTD., H. C. HASTINGS and W. L. WISE. December 20th.

29,789. "Portable electric lamps." ELECTRIC EXPORT WERKE G.m.b.H., and E. GOTTSCHALCK. December 20th. (Complete.)

29,801. "Improvements in and connected with automatic telephone exchanges." E. BLOS. December 21st.

29,861. "Improvements in and relating to electrical switches, particularly those of the bell-push variety." A. PEARCE-TOWL. December 21st.

29,862. "Improvements in and relating to the control of secondary batteries." A. HUBBARD and A. PEARCE-TOWL. December 21st.

29,878. "Coloured central reflector in electric filament lamps." J. MESZAROS and S. FAWNS. December 21st.

29,944. "Improvements in the electrical and automatic control of engines, dynamos and batteries." L. SUNDERLAND and G. C. PILLINGER. December 22nd.

29,954. "Improvements in or relating to electrical heating apparatus." A. F. BERRY. December 22nd.

29,958. "Improvements relating to the lighting systems of electric tram and like cars." J. W. DUGDALE. December 22nd.

29,963. "Automatic telephone systems." AMERICAN AUTOMATIC TELEPHONE Co. and C. L. GOODRUM. December 22nd. (Complete.)

29,985. "Improvements in or relating to telephony and telegraphy." S. G. BROWN. December 22nd.

29,995. "Improvements in electro-mechanical power transmission." C. CLEIREN. (Application for Patent of Addition to No. 4,620, 1908. Date applied for under Sec. 91 of the Act, December 24th, 1908, being date of application in Belgium.) December 22nd. (Complete.)

30,000. "Improved automatic electric flash-light device." H. F. REASON and REASON MANUFACTURING CO., LTD. December 22nd.

30,008. "Improvements in or relating to holders of incandescent electric light lamps." H. WOODHOUSE. December 23rd.

30,030. "Improvements in the production of pulsating high frequency electric currents." E. VON LEPEL and W. BURSTYN. (Date applied for under Sec. 91 of the Act, December 23rd, 1908, being date of application in Germany.) December 23rd.

30,049. "Improvement in sparking plugs for internal combustion engines." Firm of ROBERT BOSCH (Date applied for under Sec. 91 of the Act, August 25th, 1909, being date of application in Germany.) December 23rd. (Complete.)

30,051. "Improvements in time switches." H. F. REASON and REASON MANUFACTURING CO., LTD. December 23rd.

30,065. "Improvements in and relating to incandescence electric lamp and shade holders." M. HILL. December 23rd.

30,093. "Improvements in and relating to coin freed mechanism for electricity meters." C. E. HIBBERD. (Date applied for under Rule 13, June 23rd, 1909. An invention comprised in Application No. 14,758, dated June 23rd, 1909.) December 23rd.

30,101. "Improvements in and relating to contacts for contact breakers, especially applicable to inductive electrical appliances." E. TURNER and G. FENWICK. December 24th.

30,142. "Improvements in and relating to electric meters." BRITISH THOMSON-HOUSTON CO., LTD. J. GRAY and R. H. ROGERS. (Application for Patent of Addition to No. 12,689, 1909.) December 24th. (Complete.)

30,163. "Improvements in and relating to circuit-breakers for use in electric lighting and power installations." SPAGNOLETTI, LTD., and V. E. JOYCE. (Application for Patent of Addition to No. 536, 1909.) December 24th.

30,176. "Improvements in electric machines." ALLMANNA SVENSKA ELEKTRISKA AKTIEBOLAGET (Date applied for under Sec. 91 of the Act, July 19th, 1909, being date of application in Sweden.) December 24th. (Complete.)

30,177. "Improvements in telephone receivers or in attachments therefor." SIEGENBERG, jun. December 24th.

30,184. "Improvements in switches for electric circuits." H. R. SCHULTZ. December 24th.

30,185. "Improvements in automatic switches and circuit-breakers." H. R. SCHULTZ. December 24th.

30,208. "Improvements in or relating to alternate-current motors." V. A. FYNN. December 24th. (Complete.)

30,216. "Improvements in electric time switches." P. SCHRODER. December 24th. (Complete.)

PUBLISHED SPECIFICATIONS.

Copies of any of the Specifications in the following list may be obtained of MESSRS. W. P. THOMPSON & Co., 285, High Holborn, W.C., and at Liverpool and Bradford; price, post free, 9d. (in stamps).

1908.

SINGLE-PHASE INDUCTION MOTOR. G. Bestetti and F. Spinelli. 18,581. September 3rd.

PROCESS OF PRODUCING TANTALUM. Siemens & Halske Akt.-Ges. 22,873. November 7th. (Date applied for under International Convention, November 16th, 1907.)

ELECTRICALLY-HEATED APPARATUS. R. K. Hearn. 25,485. November 26th.

AUTOMATIC ELECTRIC BURGLAR ALARMS. H. B. Collier. 25,525. November 26th.

ELECTROLYTIC DEVICES SUITABLE FOR USE AS OR IN THE CONSTRUCTION OF SWITCHES, CIRCUIT MAKERS AND BREAKERS, AND OTHER APPARATUS. W. B. Thorpe and Thorpe Meter Syndicate. 25,763. November 28th. (Cognate application 12,663/09.)

ALTERNATING-CURRENT DYNAMO-ELECTRIC MACHINERY. Lancashire Dynamo and Motor Co., A. P. Wood and R. S. McLeod. 26,198. December 4th.

ELECTRICAL FUSES. A. West. 26,251. December 4th.

RESISTANCE GRIDS FOR ELECTRICAL PURPOSES. A. West. 26,252. December 4th.

ELECTRIC SHUTTER INDICATORS. H. Wandrey. 26,502. December 7th. (Date applied for under International Convention, December 7th, 1907.)

DRIVING MECHANISM FOR DYNAMOS. H. Leitner. 27,149. December 14th.

ELECTROPLATING BARREL APPARATUS. T. S. Smith and T. Deakin. 27,624. December 19th.

SUPPORTING ARRANGEMENT FOR PLATES AND ELECTRODES FOR BATTERIES AND ACCUMULATORS. A. Bilard. 28,075. September 24th.

1909.

DEVICES FOR NEUTRALISING INDUCTIVE DISTURBANCES DUE TO ELECTRIC TRACTION SYSTEMS. British Thomson-Houston Co. (General Electric Co., United States.) 466. January 7th.

ALTERNATING-CURRENT DYNAMO-ELECTRIC APPARATUS. British Thomson-Houston Co. (Allgemeine Elektricitäts Ges.) 786. January 12th. (Application for Patent of Addition to No. 23,288/02.)

ELECTROMAGNETICALLY-CONTROLLED ELECTRIC SWITCHES. A. H. Custis, A. H. Mackley and Adams Manufacturing Co. 2,217. January 29th.

ELECTRIC CONTROL SWITCH FOR MACHINE HAMMERS, RAMS, CRANES, LIFTS AND THE LIKE. K. Iffland. 3,180. February 9th.

SELF-WINDING ELECTRIC CLOCKS. F. Kirchhofer. 5,883. March 11th.

AUTOMATIC ELECTRIC CIRCUIT BREAKER. G. Hansen. 8,105. April 5th.

ELECTRICALLY-OPERATED VALVES. I. G. Waterman. 8,315. April 6th.

The Electrical Vehicle in the States.—Since the formation of the Electrical Vehicle and Central Station Association there has been no lack of information regarding the progress of the electric motor car in the American journals. At a recent meeting of the Association, reported in the *Electrical World*, President Stone drew attention to the value of this class of business, pointing out that a light commercial vehicle equalled in energy consumption 400 incandescent lamps, and that one of the heaviest commercial vehicles equalled a connected load of 935 incandescents. He asked, What central station engineer would refuse to seek such business, and what canvasser would expect to hold his position if he did not go after it?—a question which is particularly interesting on this side of the Atlantic, in view of the fact that electrical vehicle business is practically ignored by the British central station engineer. In Chicago, according to Mr. Alex. Churchward, of the G.E.Co., there are 2,300 electric vehicles, and these are increasing at the rate of 250 yearly. The vehicles run on a five or six-hour discharge rate, and can beat the petrol car—with petrol at 12 cents per gallon—where electricity costs 4 cents per K.W.-hour; moreover, the battery up-keep was less than the maintenance cost of petrol, motors and gears. The speed of pneumatic tired electric vehicles varied from 20 miles per hour with a 1,500-lb. wagon, to 16 miles per hour with a 4,000-lb. truck, and with solid tires, from 16 miles per hour with a 2,000-lb. wagon, to six miles per hour with a 20,000-lb. truck. The Boston Edison Co.'s automobile representative said that, as a result of the electrical vehicle's reliability, the company had not had an electric automobile laid up for a single day in 1909, and the cars are run on a schedule, out of the garage, which does not vary seven minutes in a month. Mr. Smith submitted the following comparison of two Boston Edison electric vehicles:—

	Old type.	*New type.*
Capacity	1,000 lb.	1,000 lb.
Car weight	4,000 lb.	3,240 lb.
Miles per charge	25	40
Battery weight...	1,275 lb.	1,050 lb.
Speed	12	12
Current...	42 amp.	23 amp.
Battery life	3,500 miles	7,500 miles